

# **Office of River Protection**

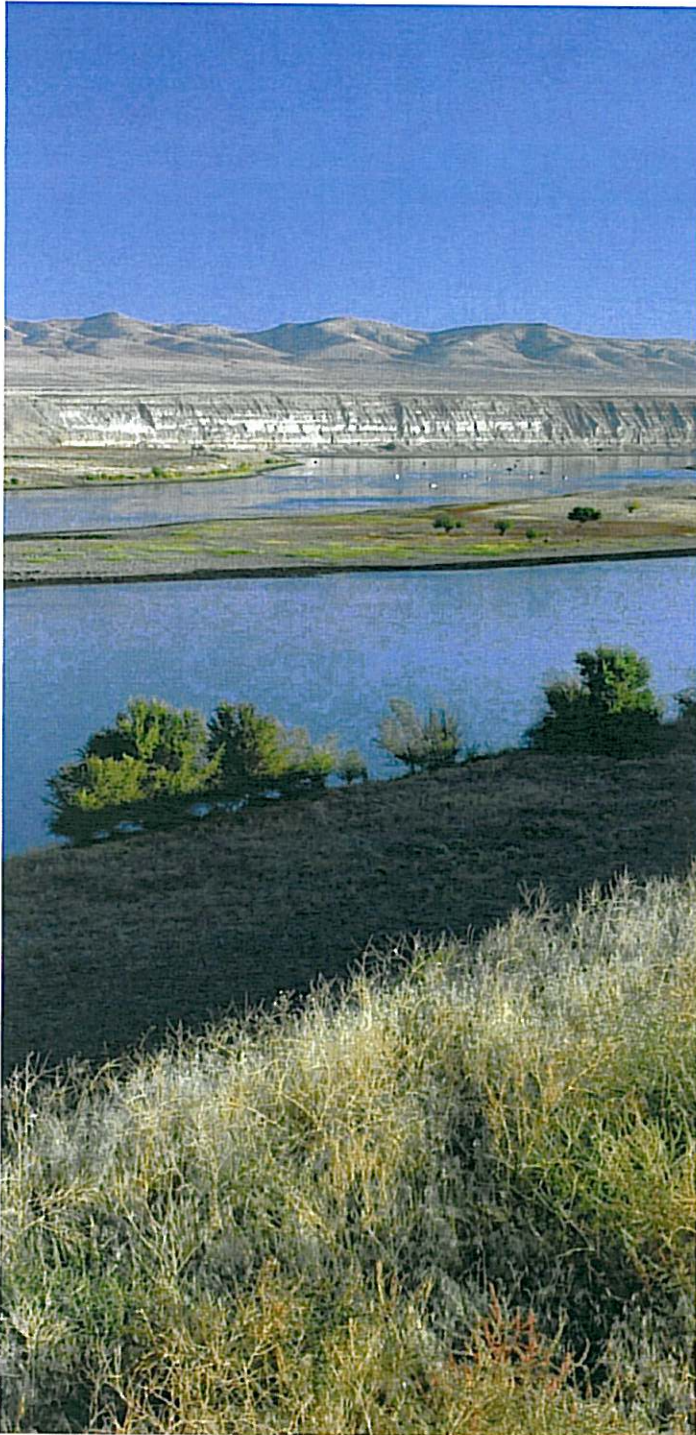
High Level Waste  
Corporate Board  
March 31, 2008

**Delmar Noyes**  
**Acting Assistant Manager**  
**Tank Farm Project**

U.S. Department of Energy



**Office of River Protection**



# Project Scope

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- Storing, retrieving, treating and disposing of tank waste and closing the Tank Farms
- Maintaining Tank Farm infrastructure consisting of 177 underground storage tanks that contain ~53 million gallons of radioactive waste from past processing operations
- Constructing and Operating the Waste Treatment Plant (WTP)
- Decontaminating and Decommissioning the WTP

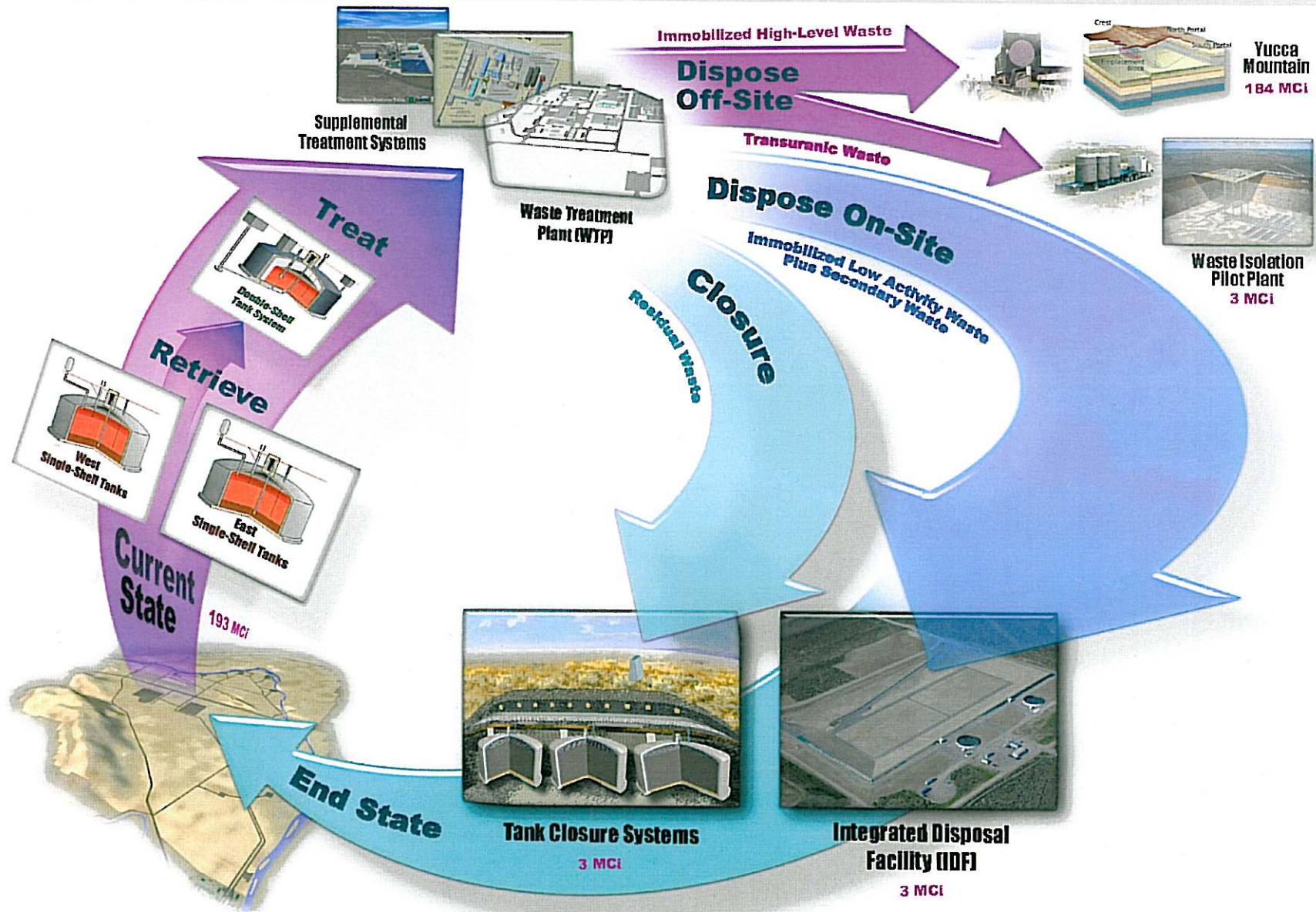


# RPP Mission Life-Cycle



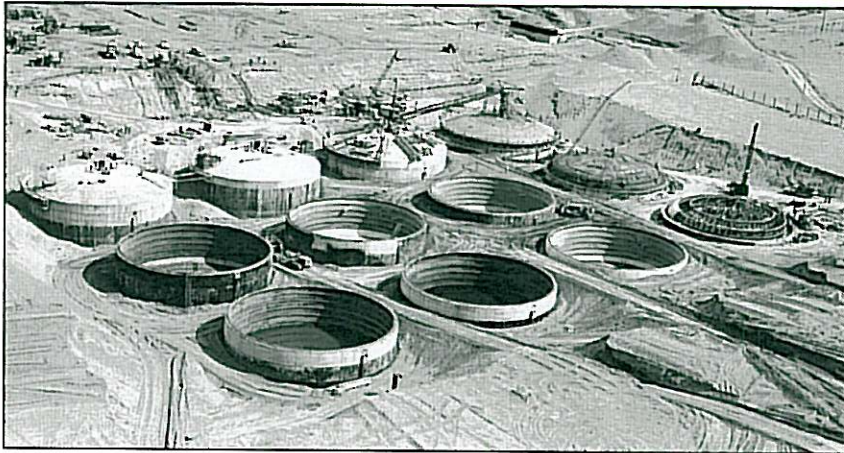
CH2MHILL

Office of River Protection





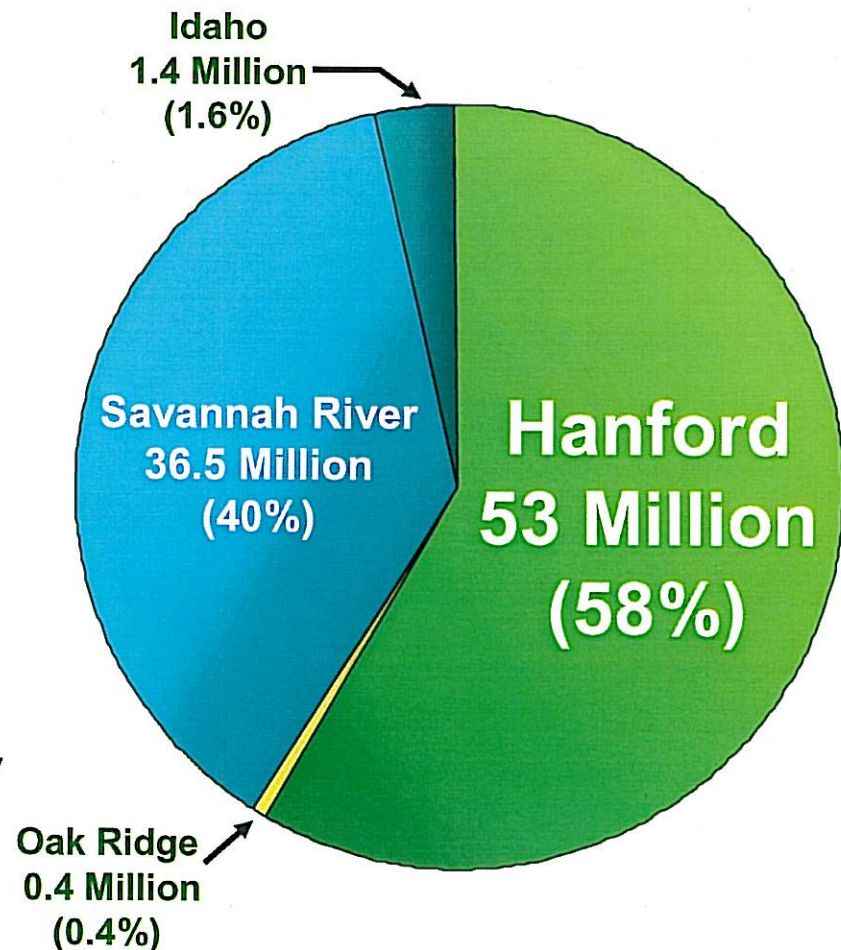
# Hanford Tank Waste Cleanup Challenge



## Hanford Site:

- 177 underground storage tanks
  - 149 Single-Shell Tanks
  - 28 Double-Shell Tanks
- ~194 million curies of radioactivity in tanks
- ~190,000 tons of chemicals

## Total Number of Gallons in Waste Tanks at DOE Sites:





# Hanford Tank Farms



March 12, 2008

ORP-08-0011



## Hanford Tank Farm Overview

- ~53 million gallons of tank waste

- 177 underground tanks

- 149 Single-Shell Tanks (SSTs)

- 28 Double-Shell Tanks (DSTs)

- 7 SSTs Retrieved to date

### 200 West Area

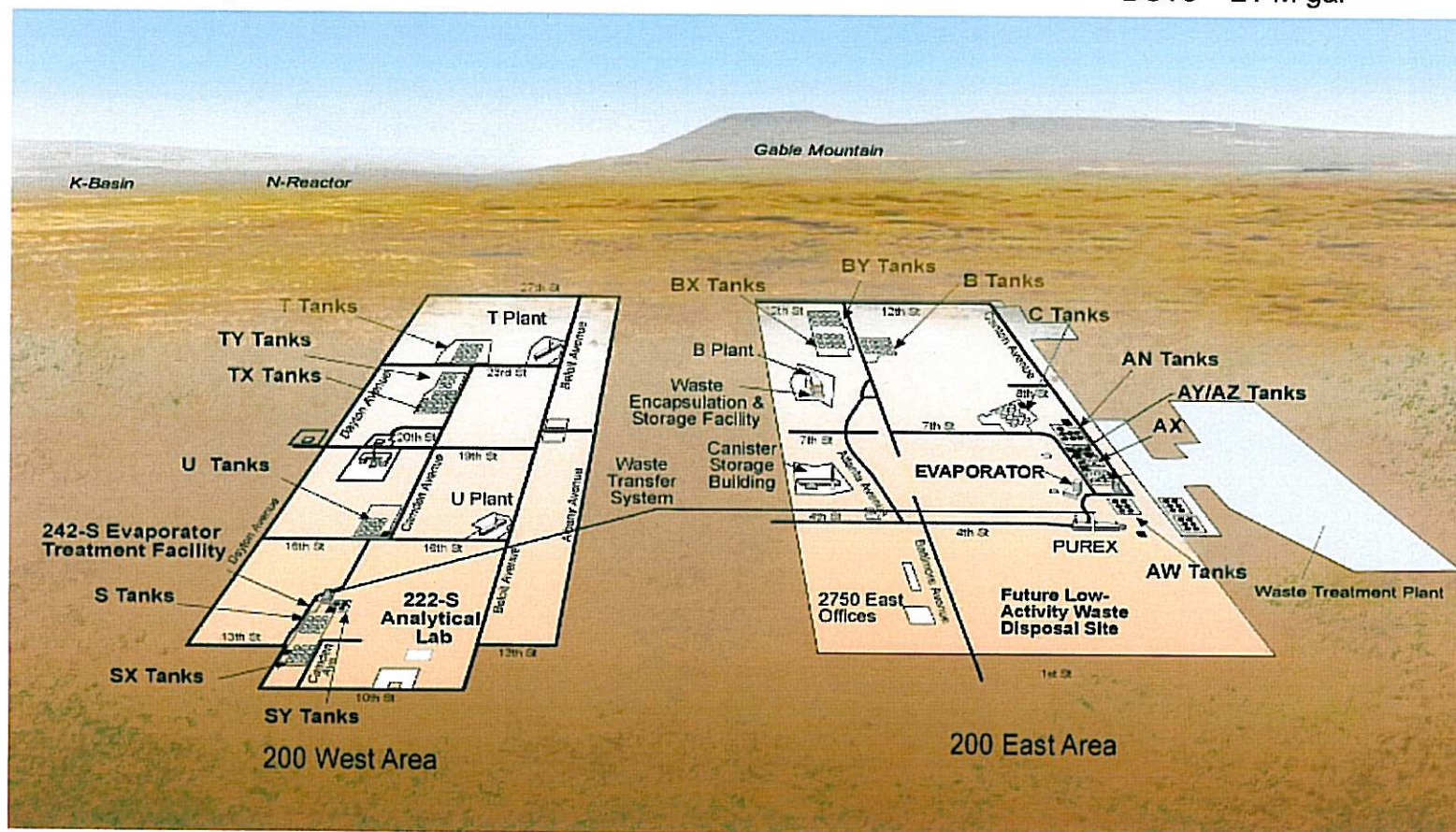
- SSTs = 19 M gal

- DSTs = 2 M gal

### 200 East Area

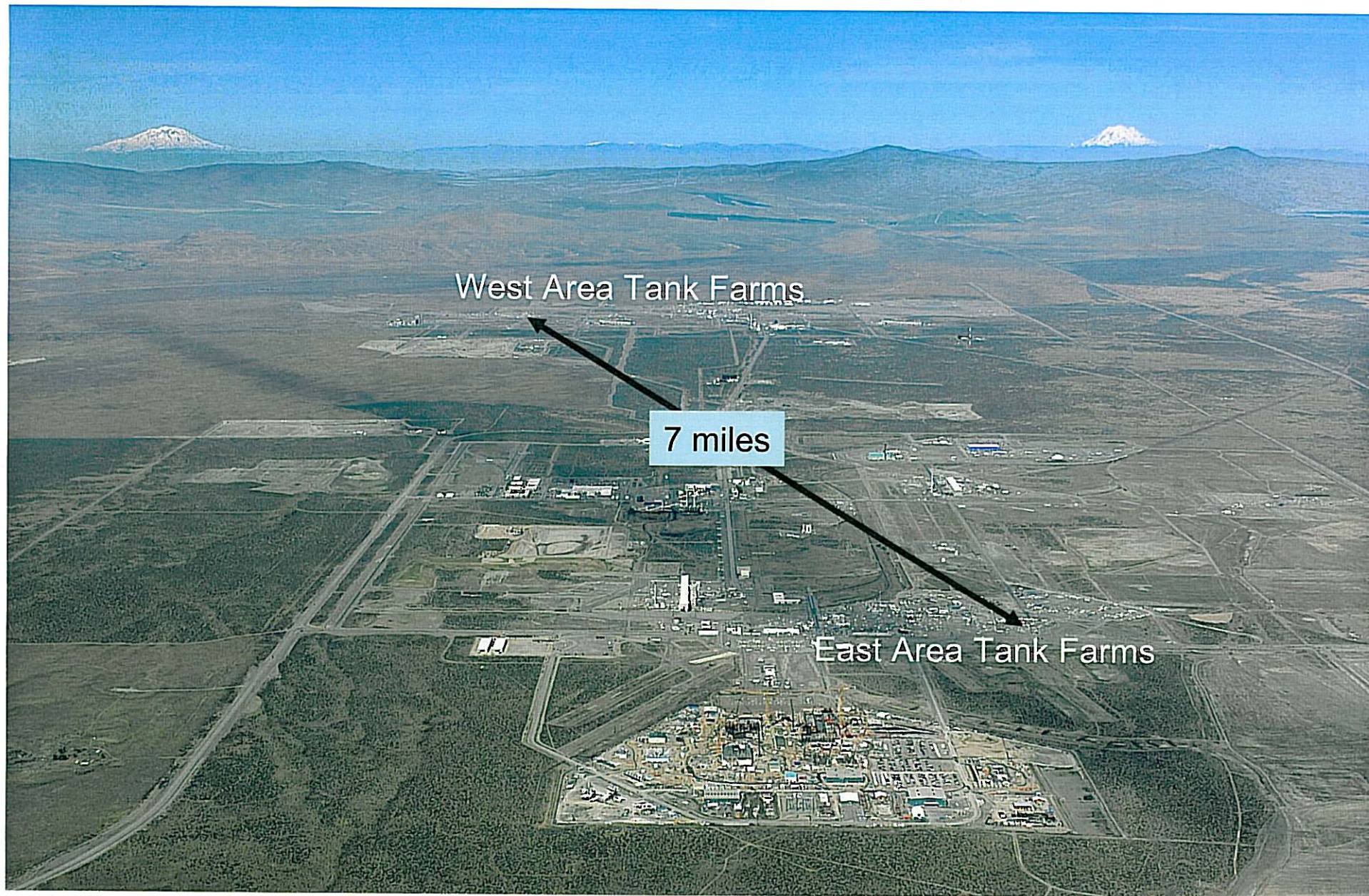
- SSTs = 11 M gal

- DSTs = 21 M gal





# Hanford 200 Area Plateau





# **Mission – Our focus remains the same**

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- Cleanup and closure of Tank Farms
  - safe operations
  - maximizing tank retrievals
  - develop and deploy retrieval technologies (10 to date) without compromising double-shell tank space needed for efficient treatment operations
- Construction of the Waste Treatment Plant by 2019; and Low-Activity Waste Vitrification Facility by 2012
- Ensuring adequate infrastructure is in place to feed WTP when it comes online
- Evaluating a viable waste treatment configuration to begin making glass as soon as possible with early LAW or supplemental treatment technologies



# Tank Farm Project Status

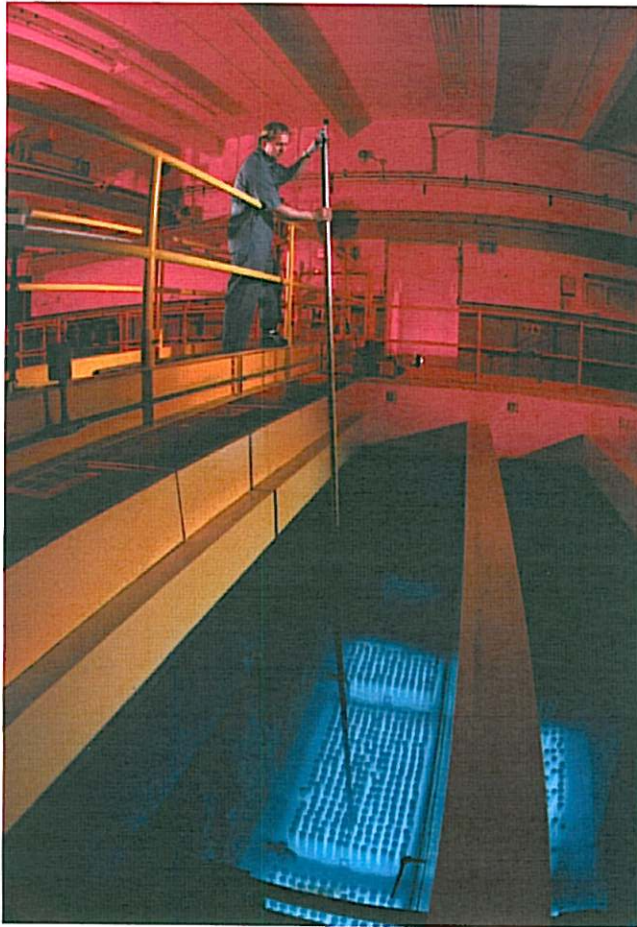
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Transferred over 294,000 gallons of radioactive and hazardous waste from single-shell tanks to safer double-shell tanks

- Seven tanks have been emptied to date
- Processed more than 2 million gallons of waste
  - reducing the waste volume in the double-shell tanks by more than 1.2 million gallons



## Richland Operations Office Cesium and Strontium Capsules

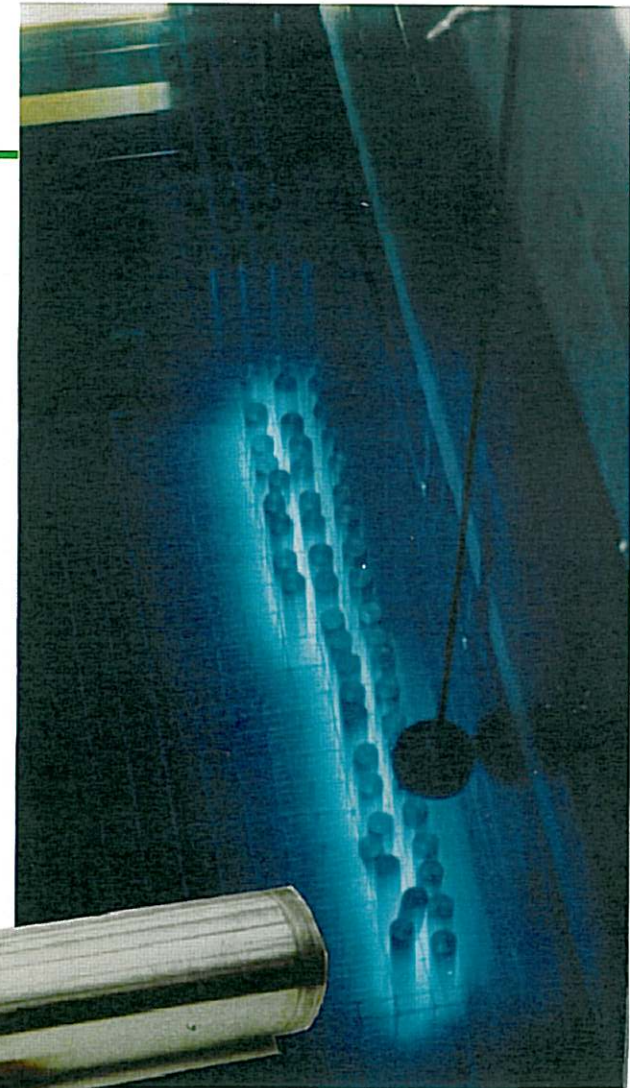


- RL is storing the 601 strontium and 1,335 cesium capsules at the Waste Encapsulation and Storage Facility (WESF)
- Capsules are considered HLW
- Baseline planning is to ship directly to the high-level waste repository in DOE Standard Canisters without further processing.
- RL strategy is to seek regulatory relief from RCRA waste designation as preliminary performance assessment modeling indicate that the regulated materials do not present a risk to human health and environment.



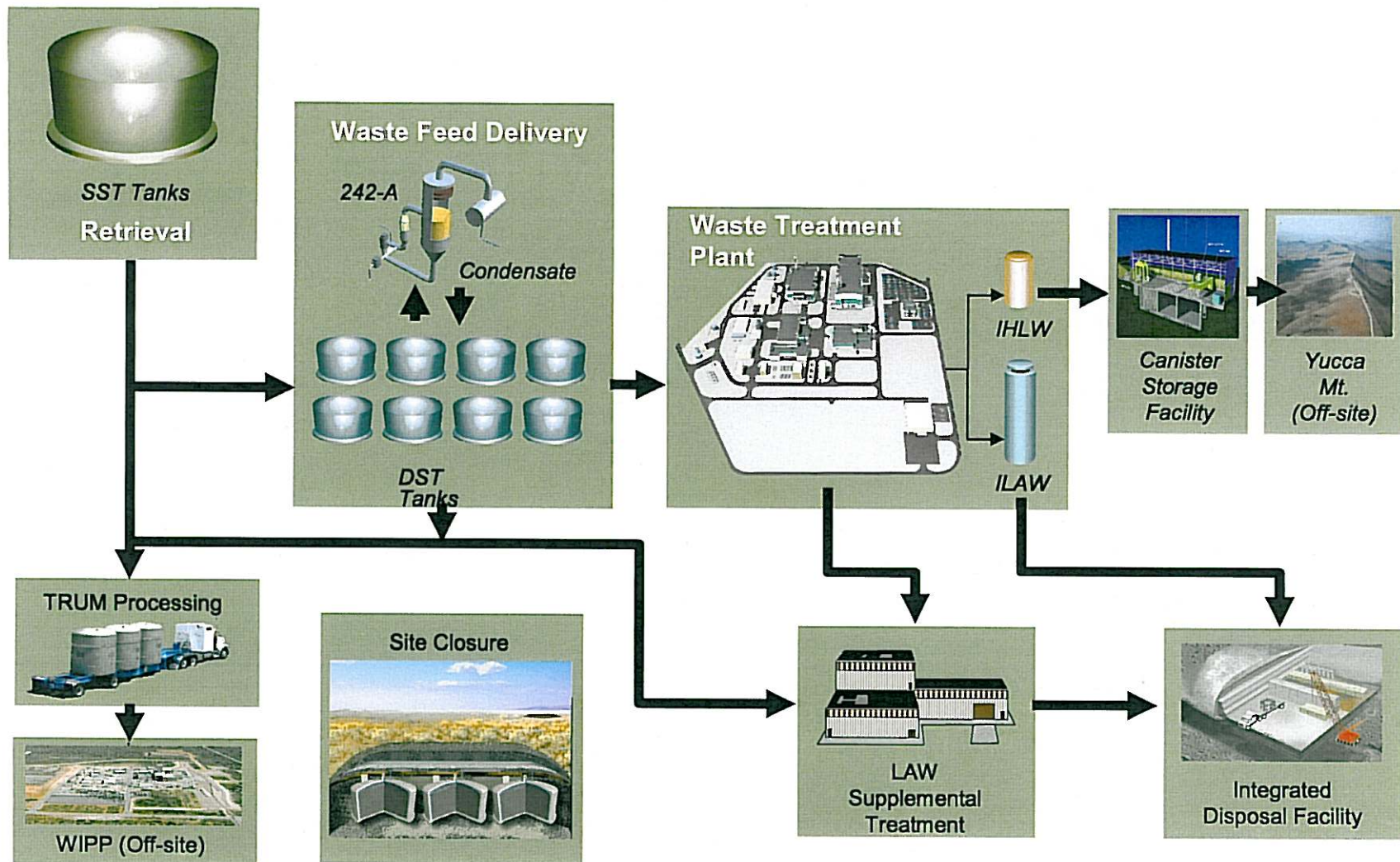
# Cesium and Strontium Capsules

- Cesium and strontium double encapsulated 1974 – 1985
- Capsules are 6.6 cm dia x 52.1 cm long (2.6 in. dia x 20.5 in. long)
- 1335 Cesium capsules contain:
  - Cesium chloride
  - $^{137}\text{Cs}$   $^{137\text{m}}\text{Ba}$   $362 \times 10^{16} \text{ Bq}$  (99 Mci)
- 601 Strontium capsules contain
  - Strontium fluoride
  - $^{90}\text{Sr}$   $^{90}\text{Y}$   $157 \times 10^{16} \text{ Bq}$  (44 Mci)



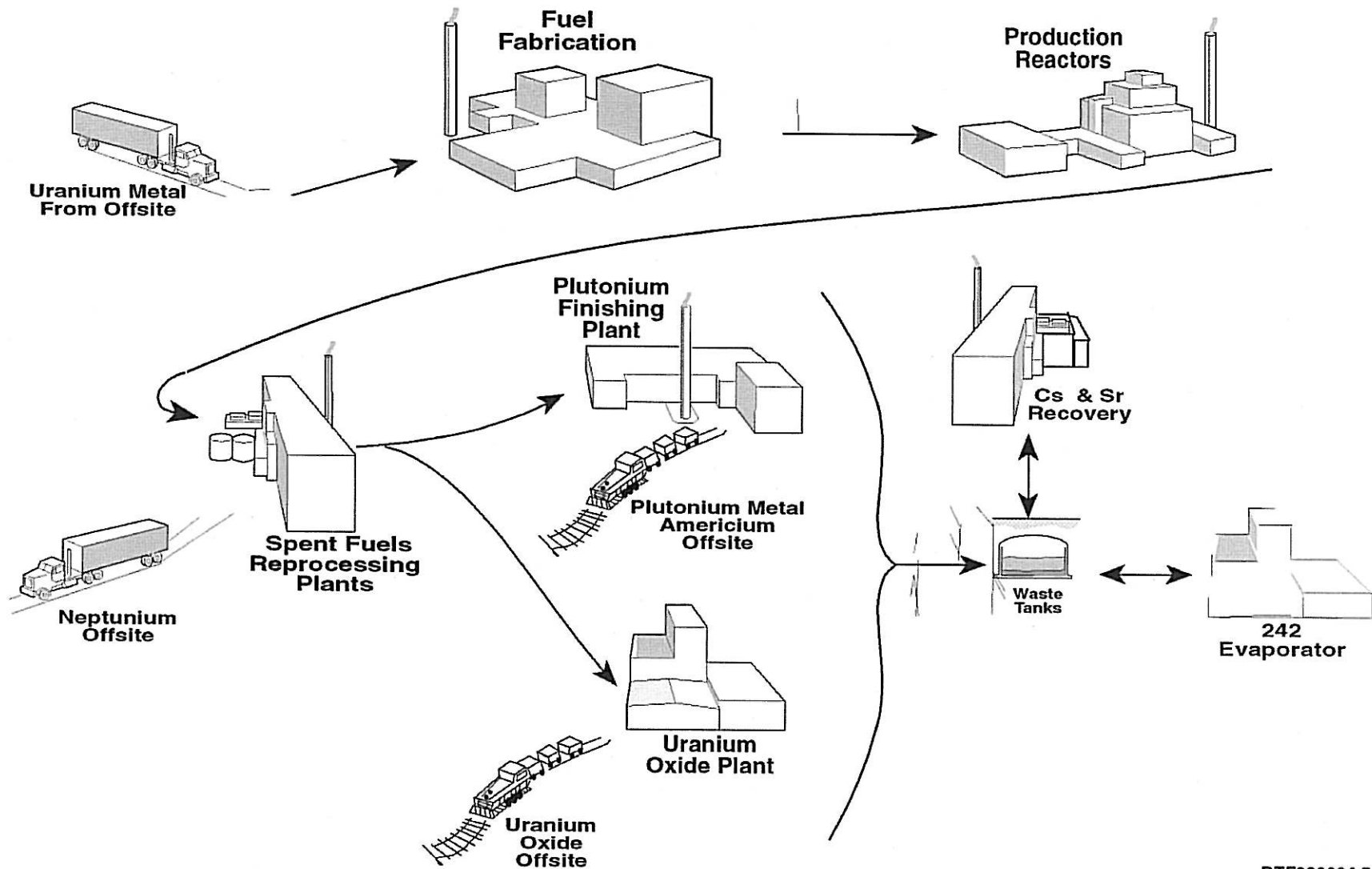
BTf0601-01 7/23/02

# River Protection Project



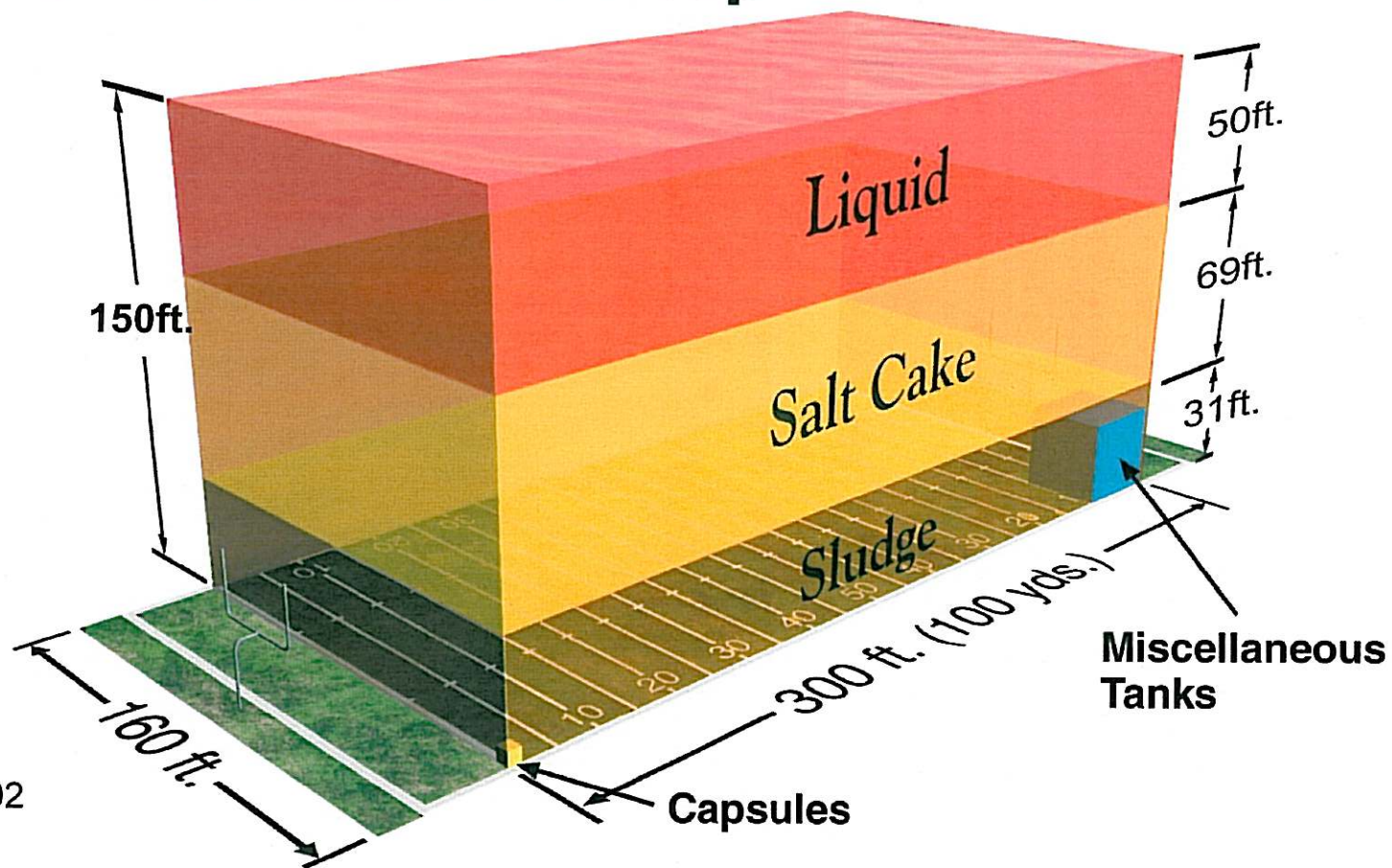


# Hanford Defense Production Facilities (1944 - 1990)



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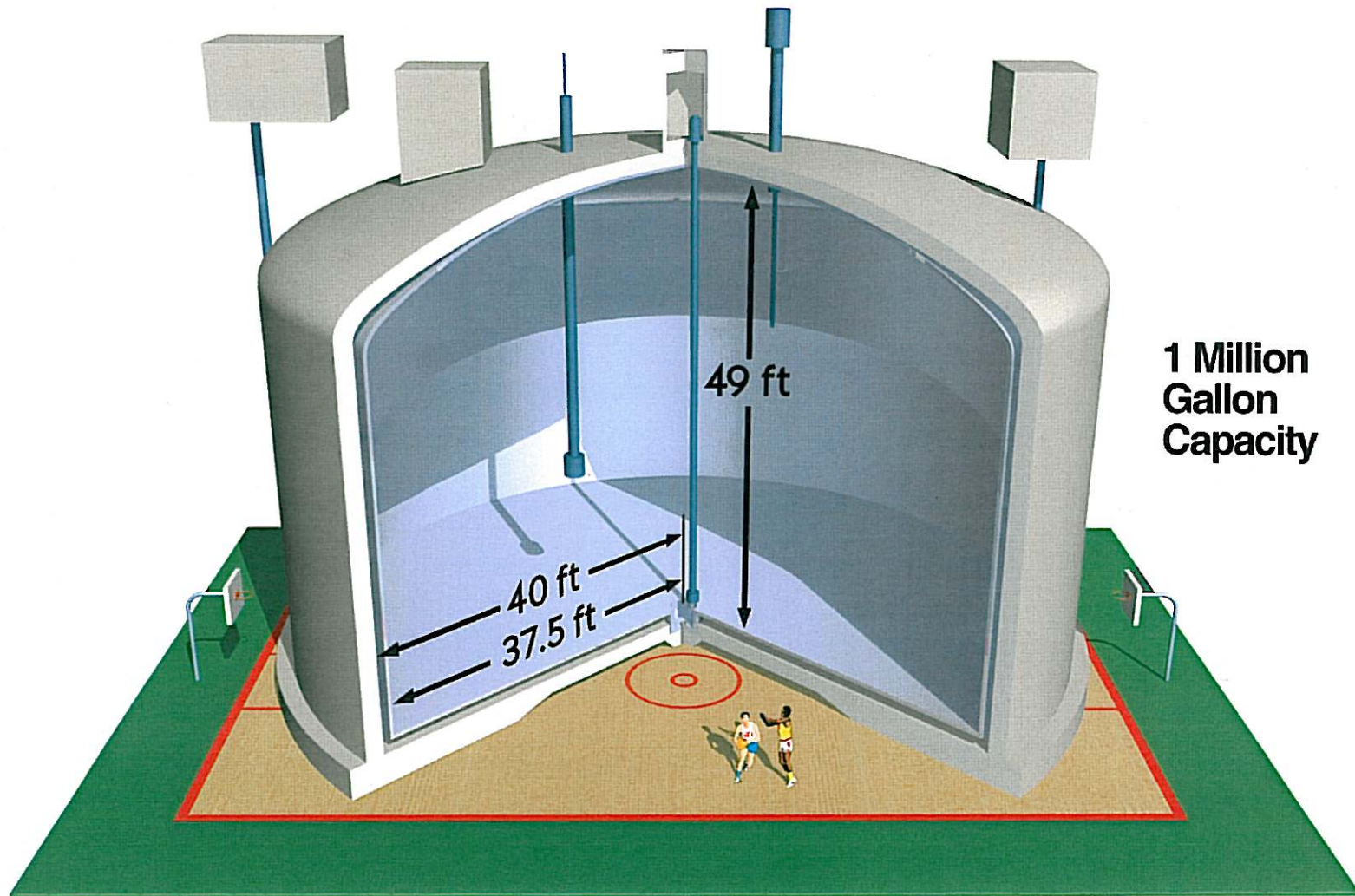
# Hanford Tank Waste Would Cover - a Football Field 150 Feet Deep



\*As of April 2002  
7/23/02

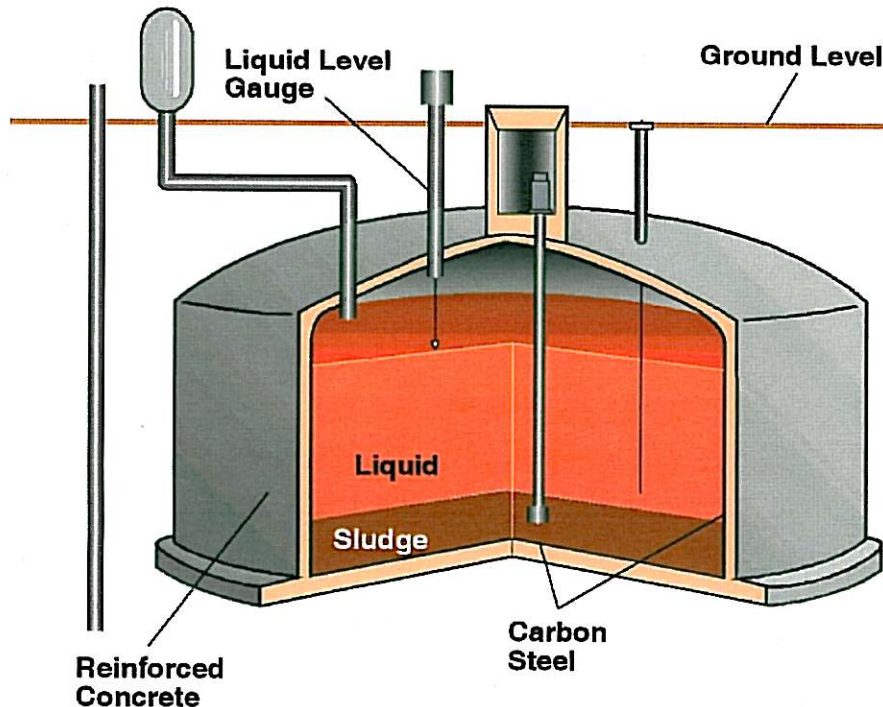


## Hanford High-level Waste Radioactive Underground Storage Tanks are Large



A97020277.1

# Single-Shell Tanks



- 149 Tanks Constructed 1943-64
- ~210 m<sup>3</sup> to 3,800 m<sup>3</sup> Capacity (55 kgal to 1 Mgal)
- Bottom of Tanks at Least 50 m (150 Feet) Above Groundwater
- No Waste Added to Tanks Since 1980
- Tanks Currently Contain:
  - ~121,000 m<sup>3</sup> (32 Mgal) of Salt Cake, Sludge, and Liquid
  - ~370 x 10<sup>16</sup> Bq (100 MCi)
- 67 Are Assumed to Have Leaked ~ 3,800 m<sup>3</sup> (~1 Mgal)

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Rev. Date 7/23/02



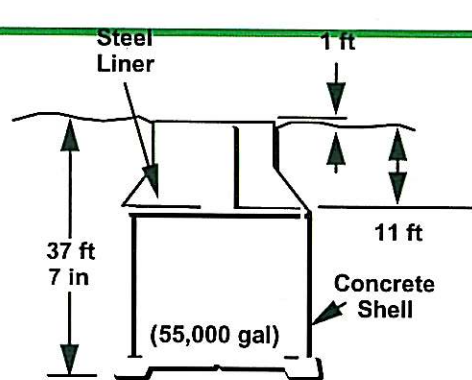


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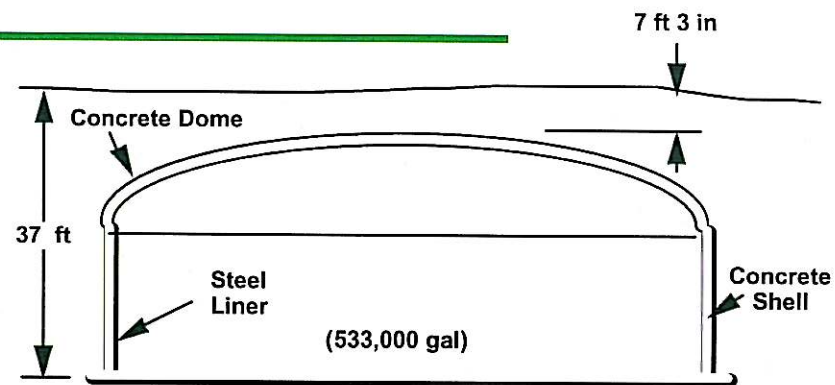
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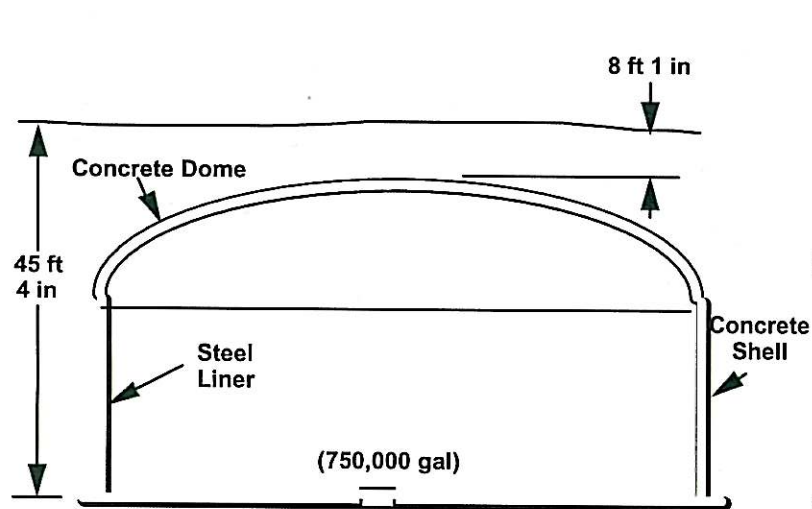
# Cross-Sectional Views of Hanford Single-Shell Tanks



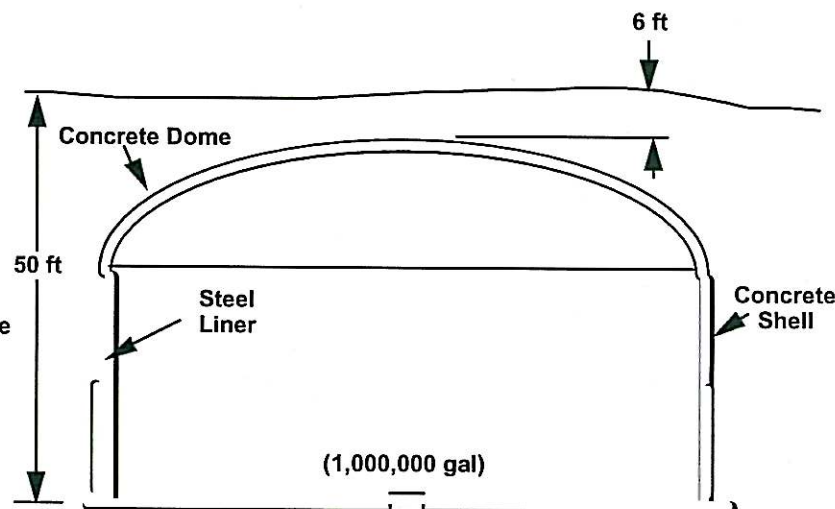
20 ft Diameter Single-Shell Tank



75 ft Diameter Single-Shell Tank



75 ft Diameter Single-Shell Tank

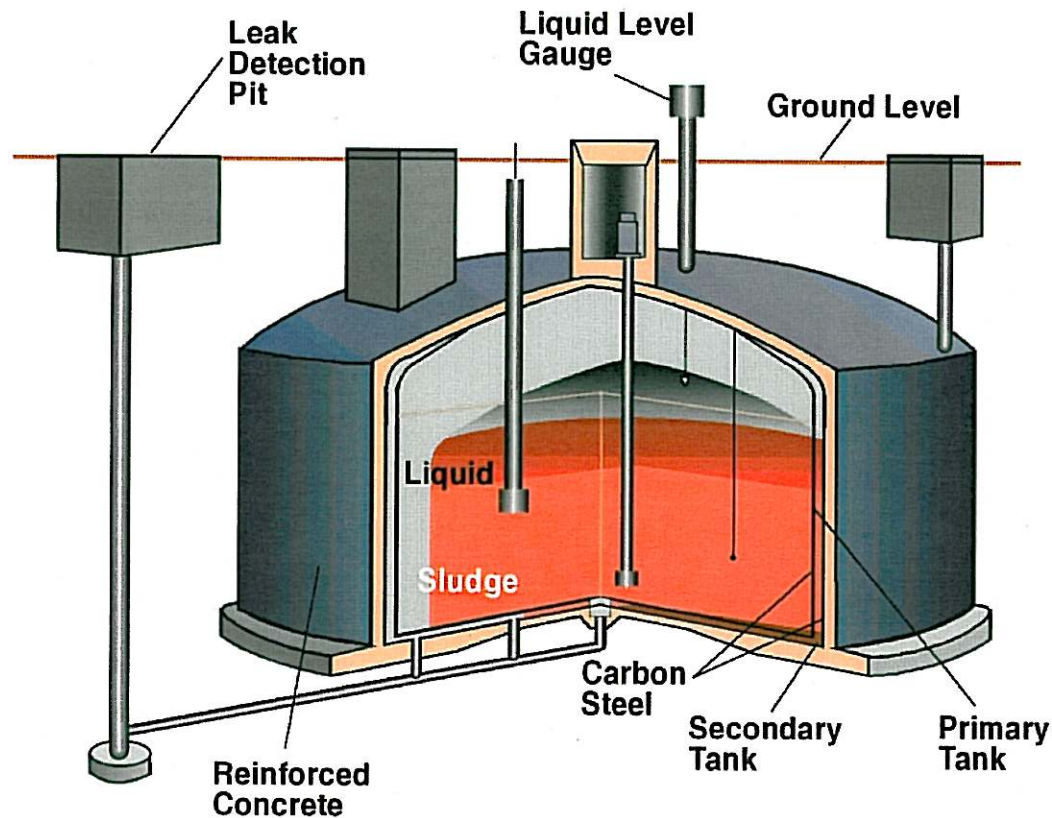


75 ft Diameter Single-Shell Tank

29003050.61



# Double-Shell Tanks



- 28 Tanks Constructed Between 1968-86
- ~3,800 m<sup>3</sup> to 4,300 m<sup>3</sup> (1 to 1.14 Mgal) Capacity
- Tanks Currently Contain
  - ~ 83,000 m<sup>3</sup> (22 Mgal) of Mostly Liquids (Also Sludges and Salts)
  - ~ 333 x 10<sup>16</sup> Bq (90 MCi)
- None Have Leaked

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## *Double-Shell Tanks under construction*







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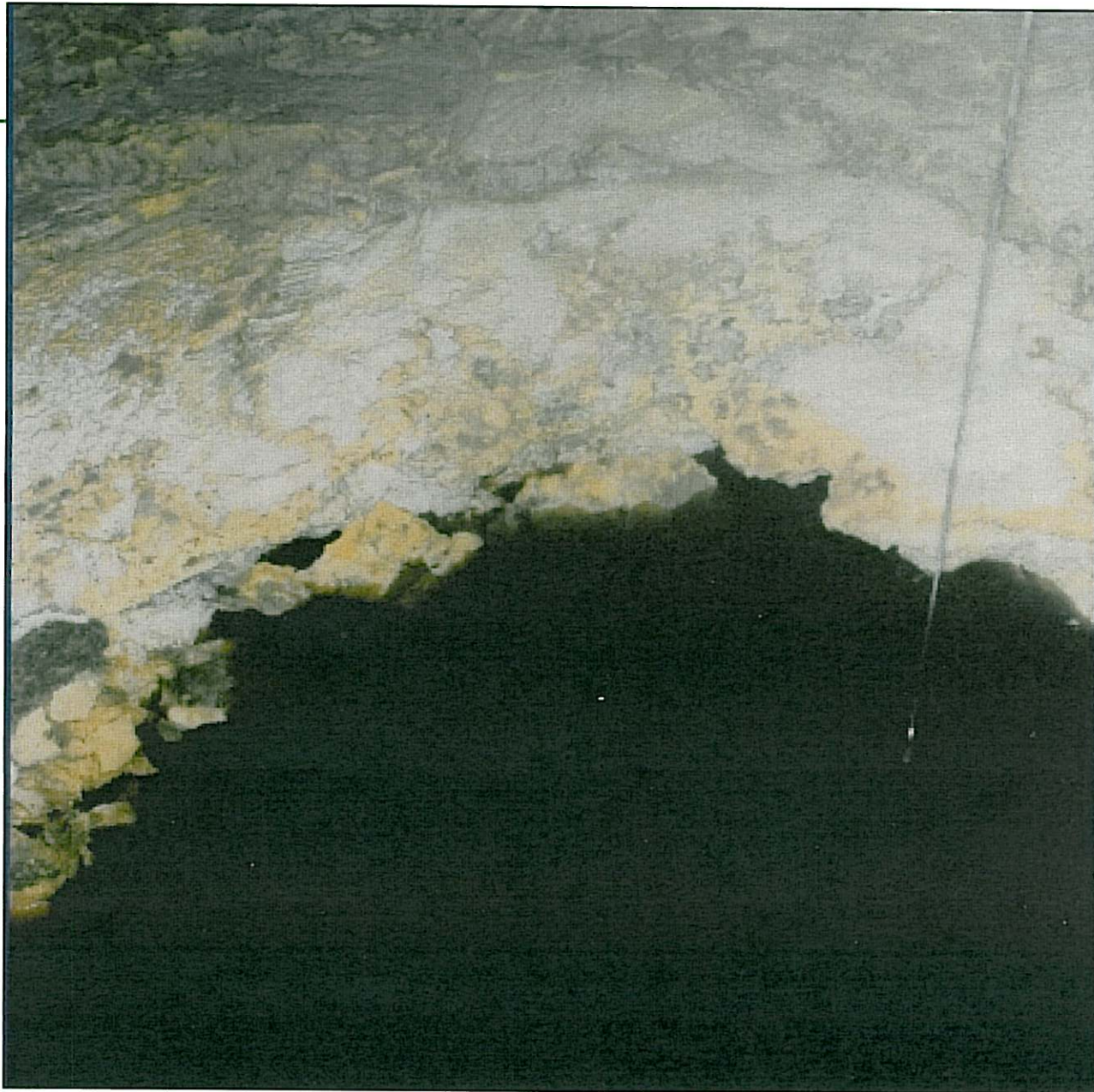




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## *Program History*

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- 1956: First tank leak discovered
- 1958: First waste treatment plan, calcine 1/3, solidify 2/3 in tanks -- not implemented
- 1960s-1970s: Concern over more tank leaks and lack of tank space, growing interest in radioisotopes
  - Removed primary heat producers (Sr-90 and Cs-137)
  - Operated in-tank solidification systems
  - Encapsulated Sr-90 and Cs-137
  - Constructed double-shell tanks
- 1975: First waste management EIS issued

## *Program History (cont.)*

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- 1980: Stopped adding waste to single-shell tanks
- 1983: DOE issues plan. Savannah River HLW first, Hanford second, Idaho third. For Hanford:
  - Retrieve DST waste, divide in two fractions, vitrify HLW for repository disposal, grout LAW and dispose onsite
  - Solidify SST waste and dispose in place
  - EIS preparation started
- 1986: Last eight double-shell tanks constructed



## *Program History (cont.)*

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- 1987/1988: EIS/ROD issued. Followed plan except for:
  - Disposal of SST waste in place not acceptable to public
  - SST decision deferred until additional development and evaluation
- 1989: Grout facility immobilized 1 million gallons of waste, Hanford Waste Vitrification Plant designed
- 1989: Tri-Party Agreement signed
- 1990: Tank safety issues identified, 54 tanks placed on “watch list”

### *Program History (cont.)*

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- 1991: Secretary Watkins directed formation of the Tank Waste Remediation System as a single project
- 1993: Hanford Waste Vitrification Project terminated because:
  - Tank waste safety issues would take active intervention
  - Modification of existing facility for waste treatment could not achieve full environmental compliance
  - Policy decision to retrieve all tank waste, increased volume of waste to be treated four-fold
- 1994: New strategy developed and Tri-Party Agreement amended



## *Program History (cont.)*

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- 1995: Decision to privatize waste treatment
- 1996-97: EIS/ROD issued
  - All waste retrieved and vitrified
  - Project to be done in two phases
  - Decision on capsules deferred
- 1997: Cross-site transfer line constructed
- 1998: Office of River Protection formed
- 1999: Retrieved waste from single-shell tank C-106

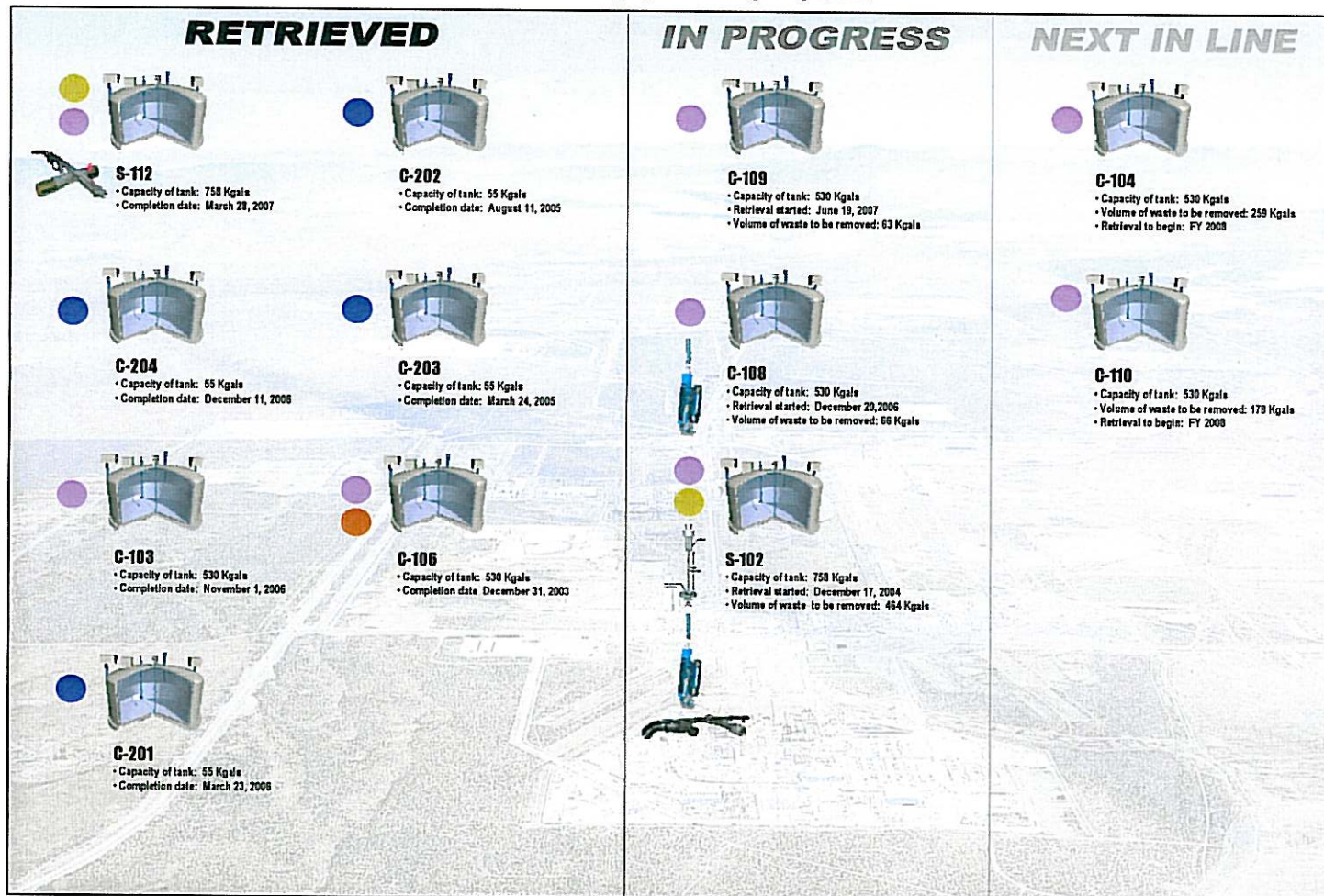
## *Program History (cont.)*

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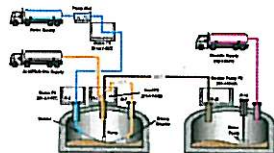
- 2000: Privatization terminated and contract awarded  
to Bechtel National Inc.
- 2001: Last tanks removed from the Watch List
- 2002:
  - 133 Single-shell tanks interim stabilized
  - Waste retrieval Cold Test Facility constructed
  - Waste Treatment Plant construction started



Retrieval Summary Updated through July 1, 2007

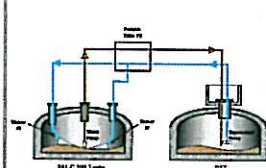


● Acid Dissolution

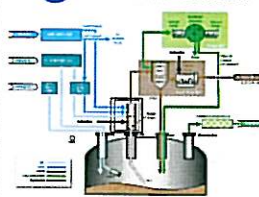


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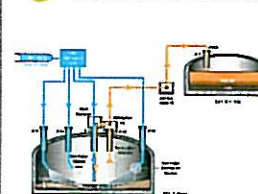
● Modified Sluicing



● Vacuum Retrieval



● Saltcake Dissolution



Remote Water Lance (Salt Mantis)



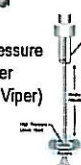
Mobile Retrieval Tool (Sand Mantis)

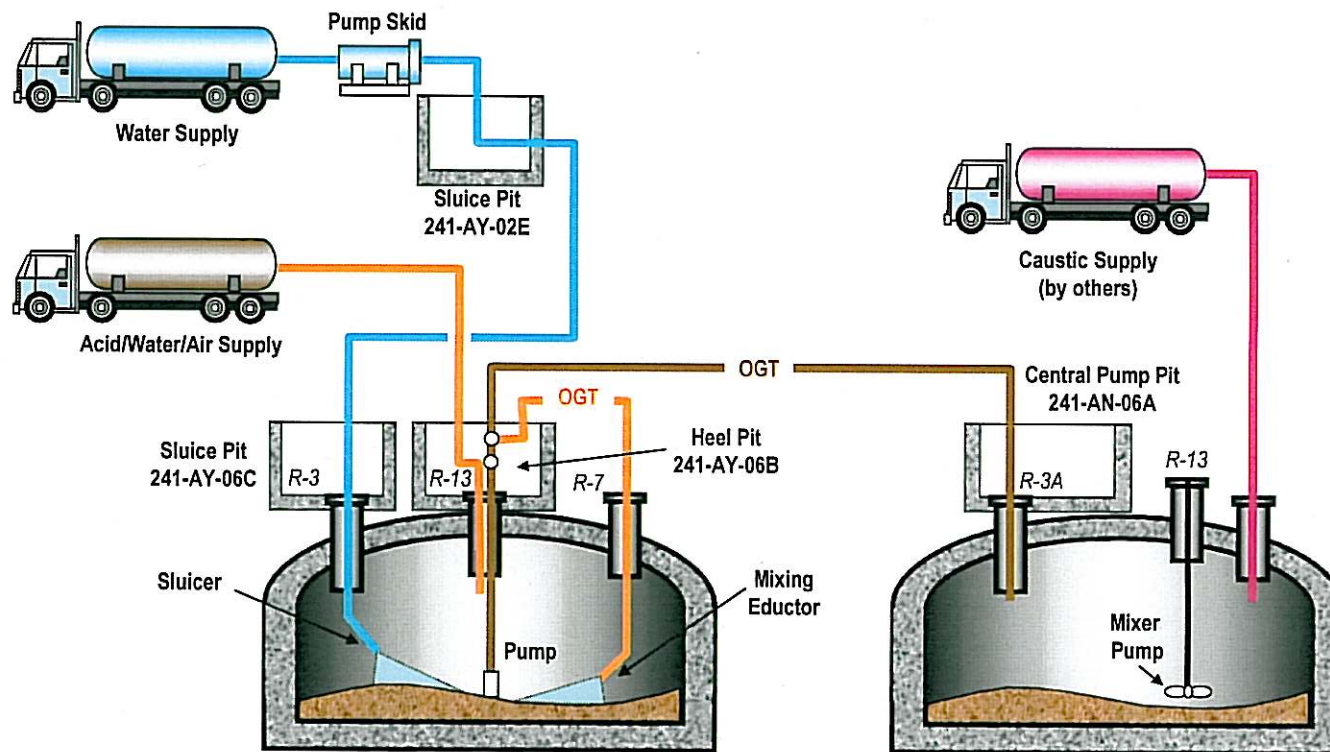


Mobile Retrieval Tool (Foldtrack)



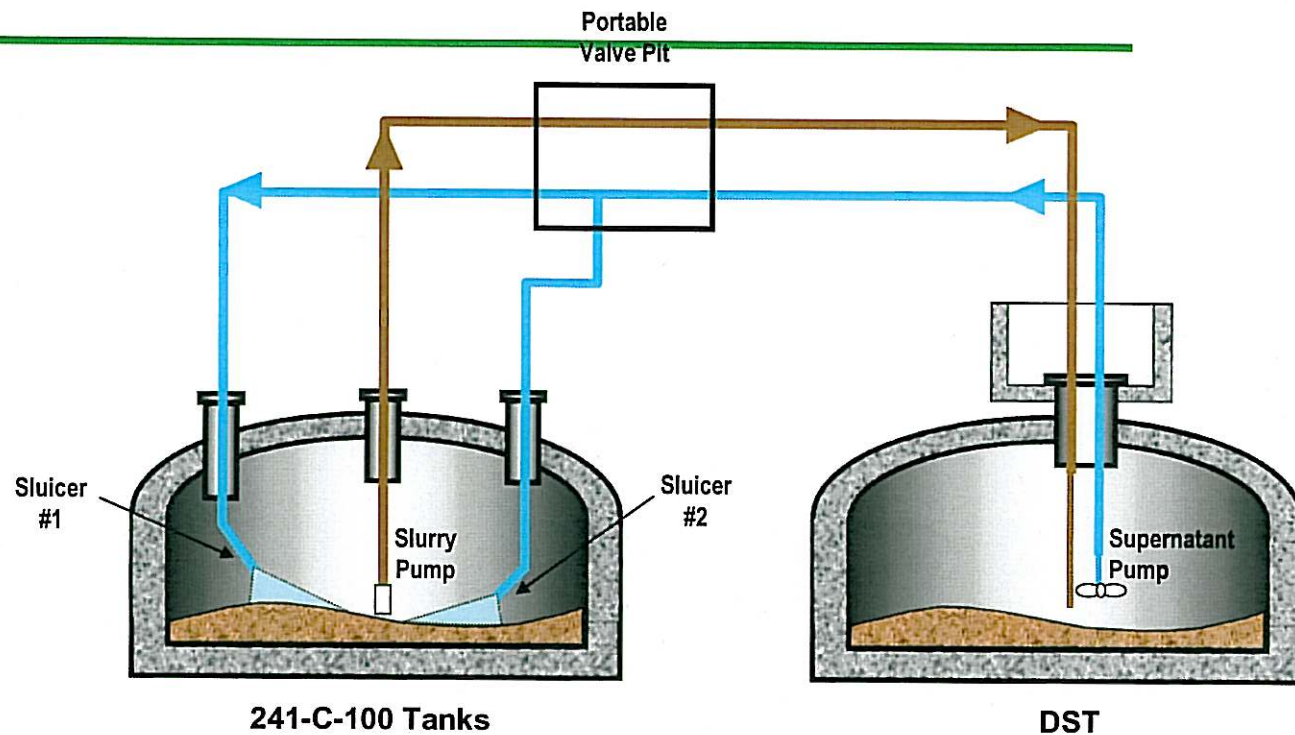
High Pressure Mixer (Rotary Viper)



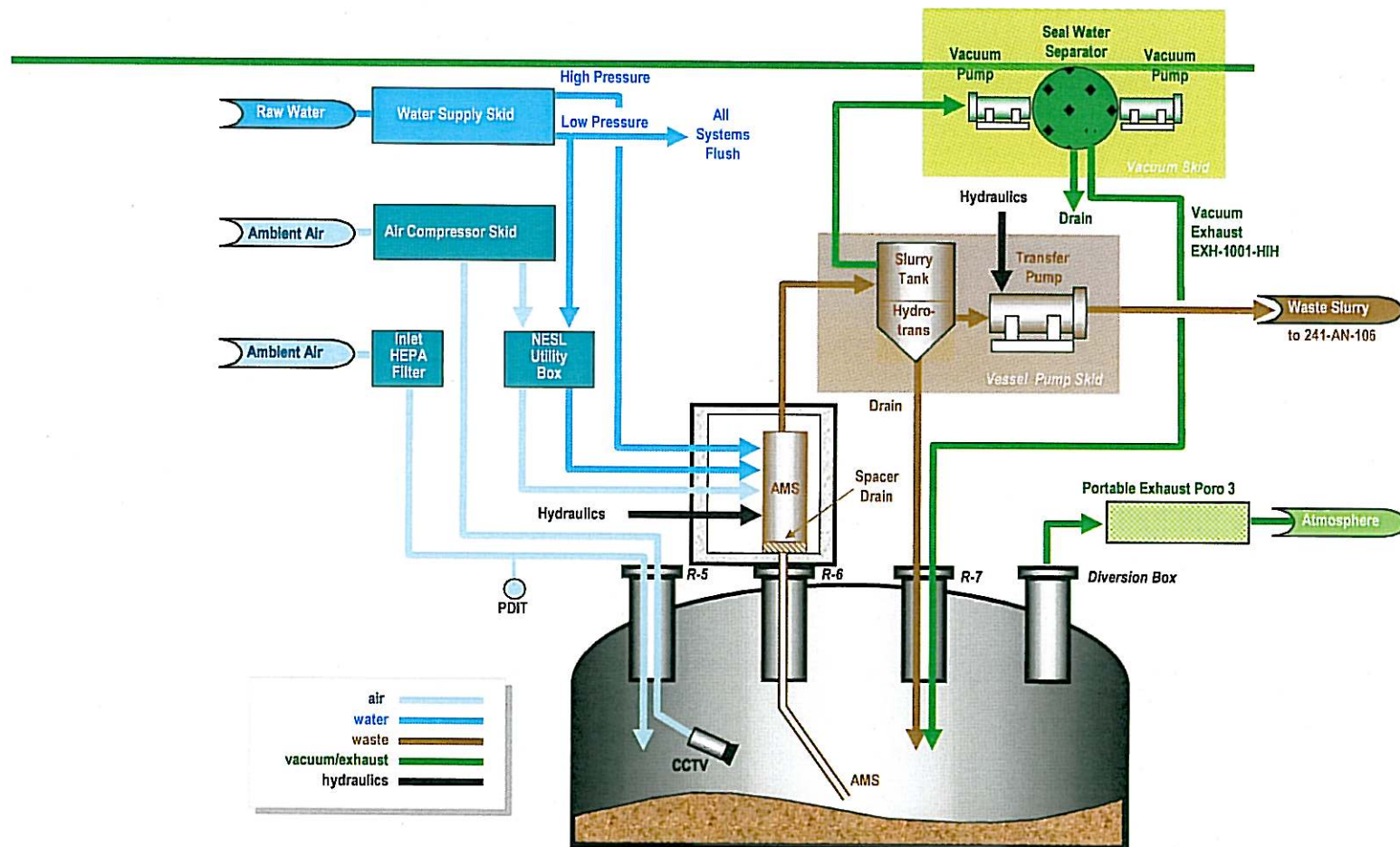


# Acid Dissolution



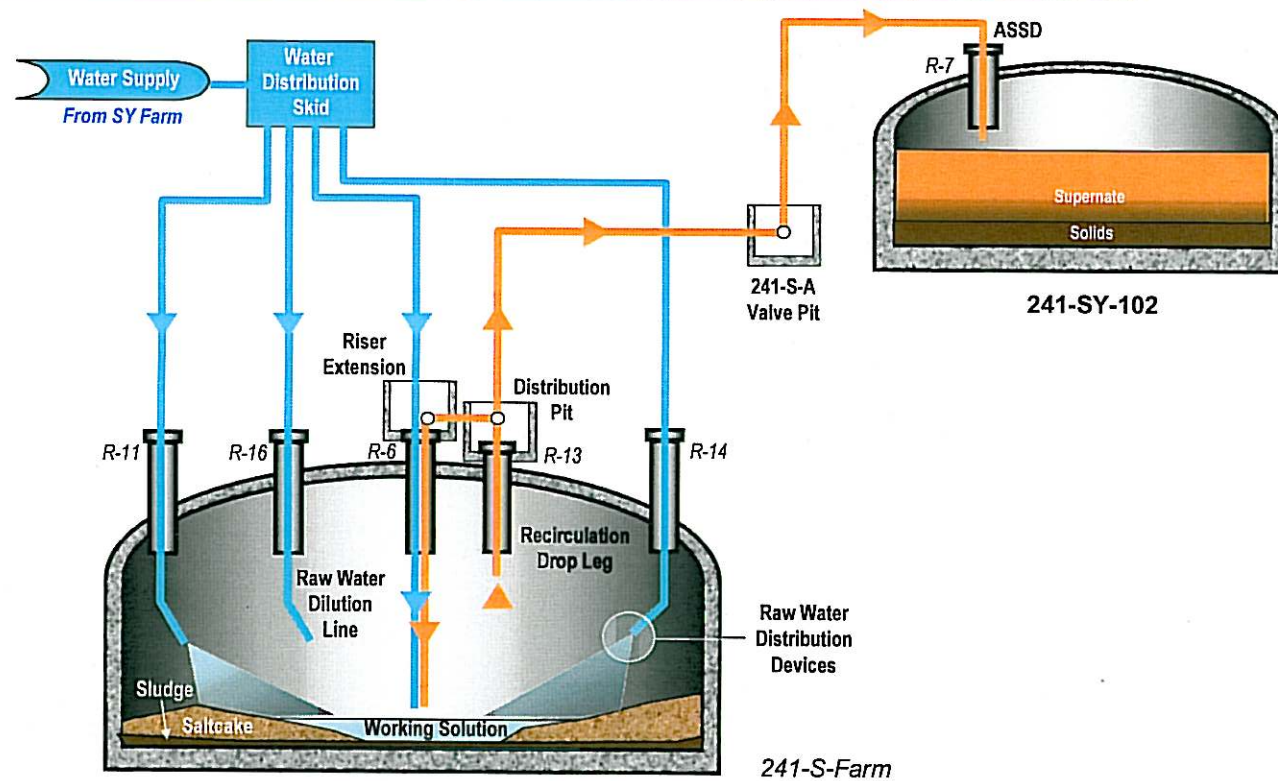


# Modified Sluicing

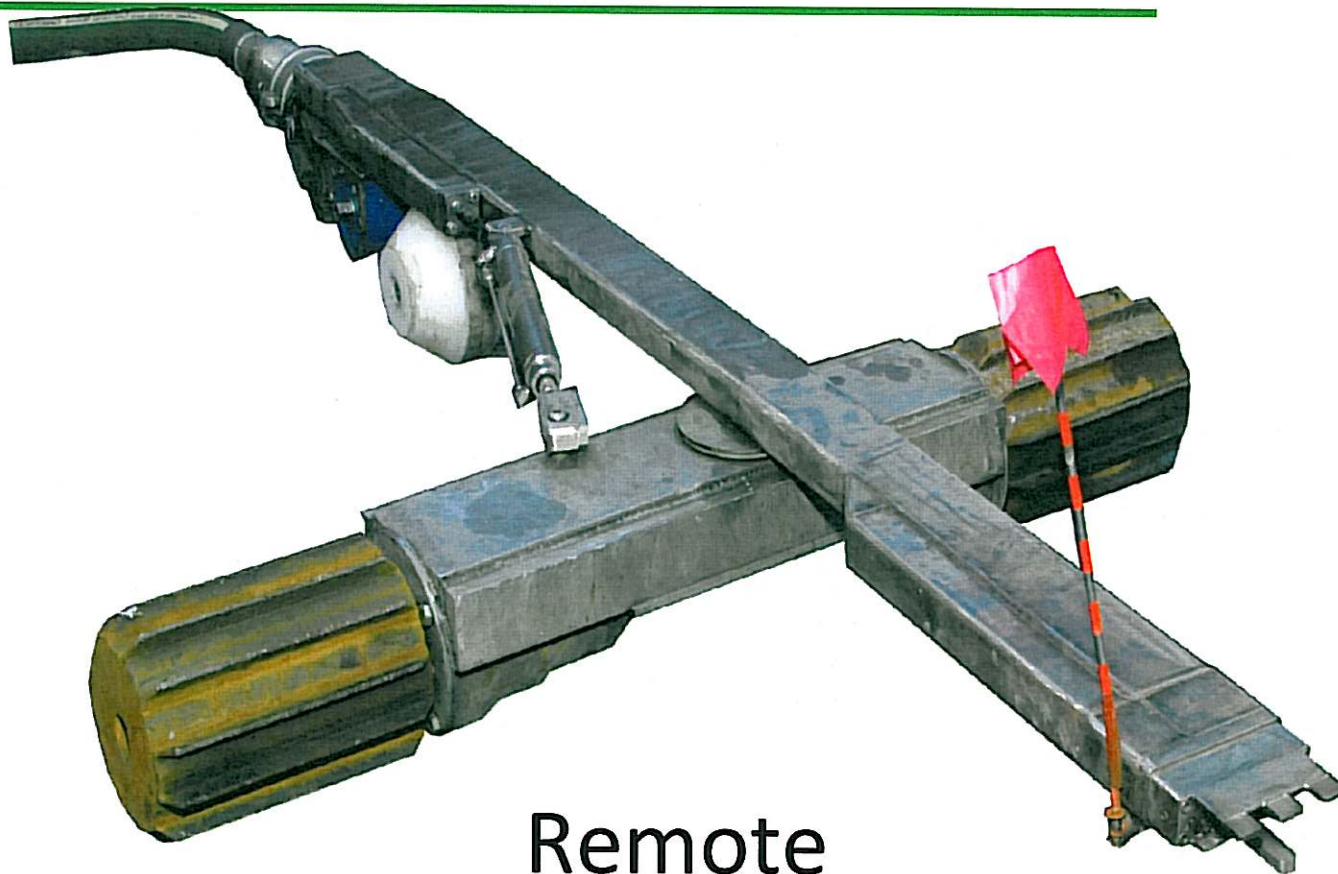


# Vacuum Retrieval





# Saltcake Dissolution



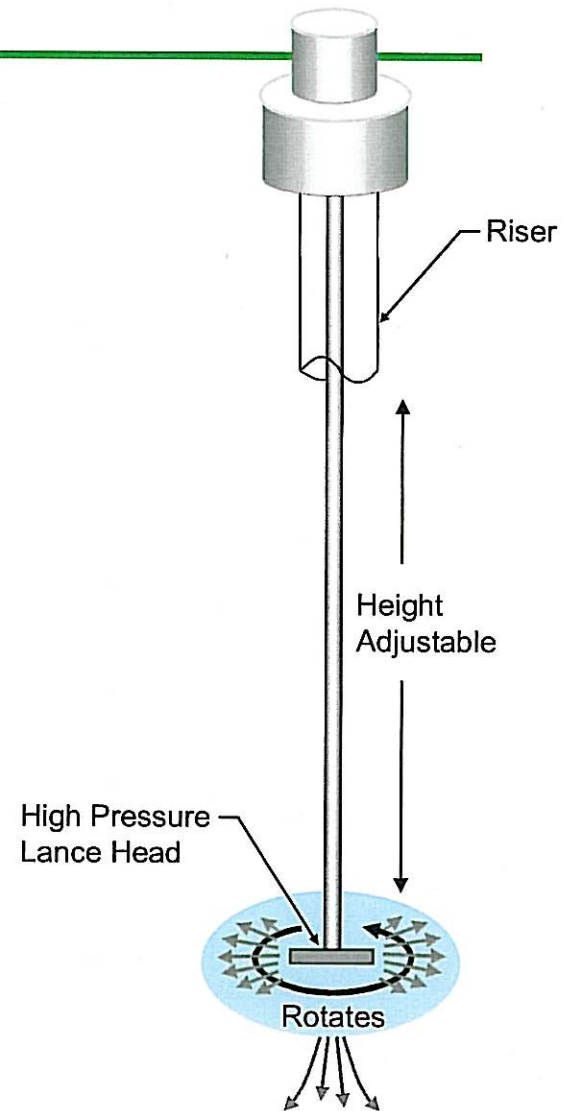
Remote  
Water Lance  
(Salt Mantis)





## Mobile Retrieval Tool (Sand Mantis)

# High Pressure Mixer (Rotary Viper)



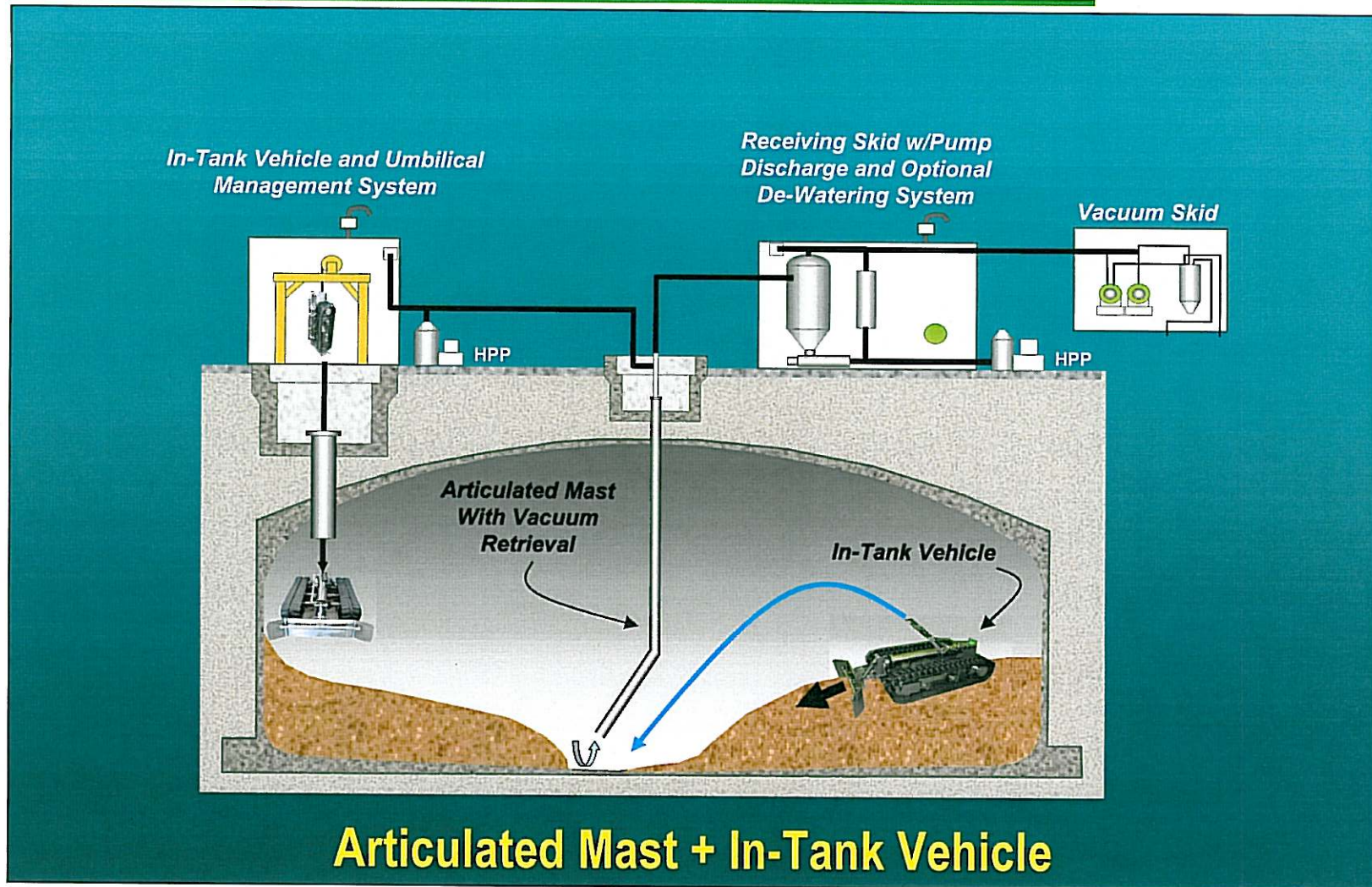


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## Mobile Retrieval Tool (FoldTrack)



## *Mobile Retrieval System - Future*





- Tank Space
  - Waste will remain in most SSTs longer consistent with extended treatment mission duration
  - SST Integrity Program to provide improved information
  - DST space to retrieve SST wastes limited until WTP startup
- Retrievals
  - Limited to ~ one SST retrieval per year until WTP startup
  - Early LAW potentially enables 5 – 10 additional SST retrievals before full WTP startup
  - Improved technologies desirable;
    - hard heel removal
    - known and suspected leaker tanks
- Tank Closure
  - No closures envisioned prior to TC&WM EIS ROD
  - TPA Appendix I identifies RCRA closure process
  - DOE must determine tank residuals are not HLW prior to closure

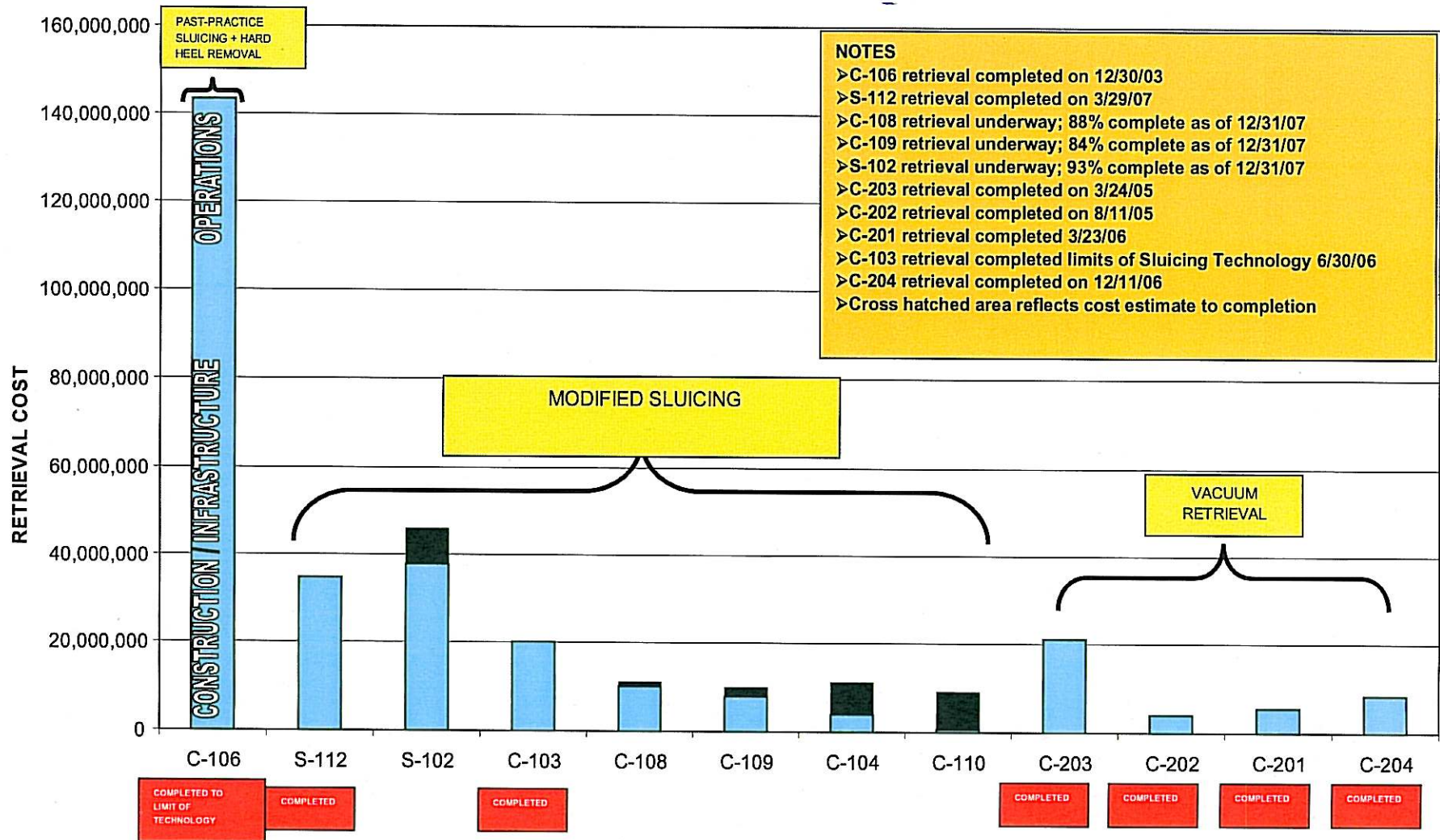
## *How is the Vitrified Waste Stored?*

- High Level Waste Canisters
  - 2' x 14.5'
  - 6,600 pounds of glass
  - Temporarily stored in Hanford's Canister Storage Building until national repository built
  - Plan to generate 12,000 – 15,000 canisters
- Low Activity Waste Containers
  - 4' x 7.5'
  - 13,000 pounds of glass
  - Stored at Hanford's Central Plateau
  - Plan to generate 30,000 – 40,000 Containers





# Better, Faster, Cheaper



## *Sampling Challenges*

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- Multiple waste forms create multiple sampling challenges
  - Supernatant liquid
  - Interstitial liquid
  - Sludge
  - Saltcake
  - Slurry





## *Evolution of Sampling Technologies*

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### Chemical Sampling

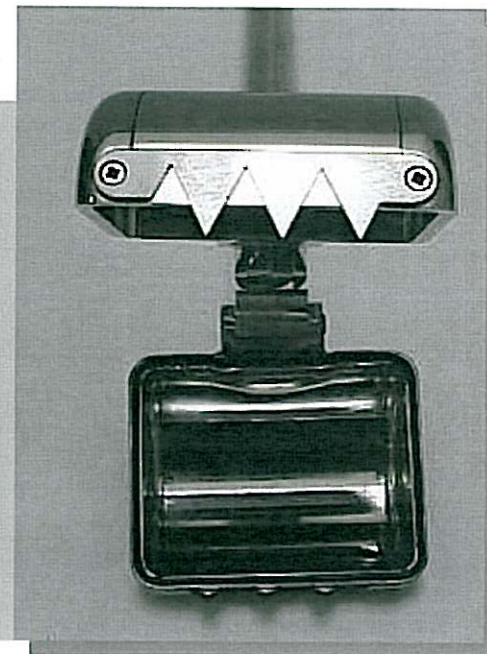
- Grab Sampling
- Finger Trap
- Core Sampling

### Residual Waste Sampling

- Off-Riser Sampling
- Alligator



Off-Riser Sampler



Alligator

## *Protecting the Environment*

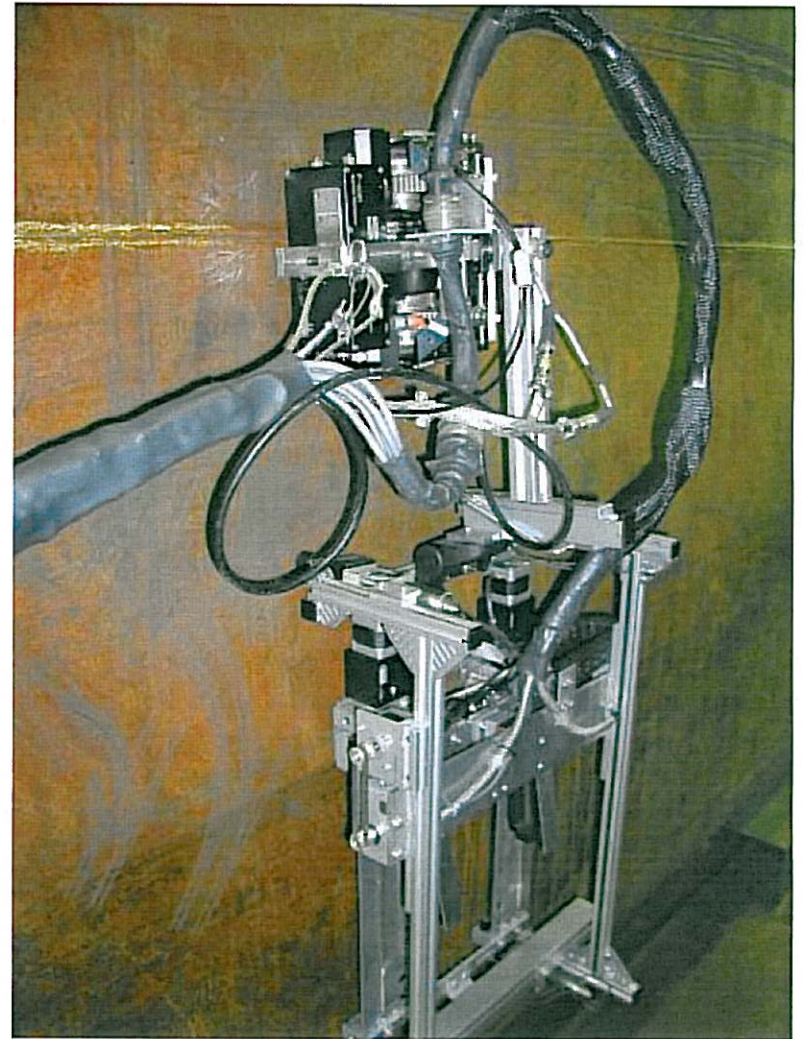
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### **Sampling Outside the Tanks**

- Direct Push
- Boreholes

### **Continued Waste Management**

- Ultrasonic testing of double-shell tanks
- Cold Test Facility



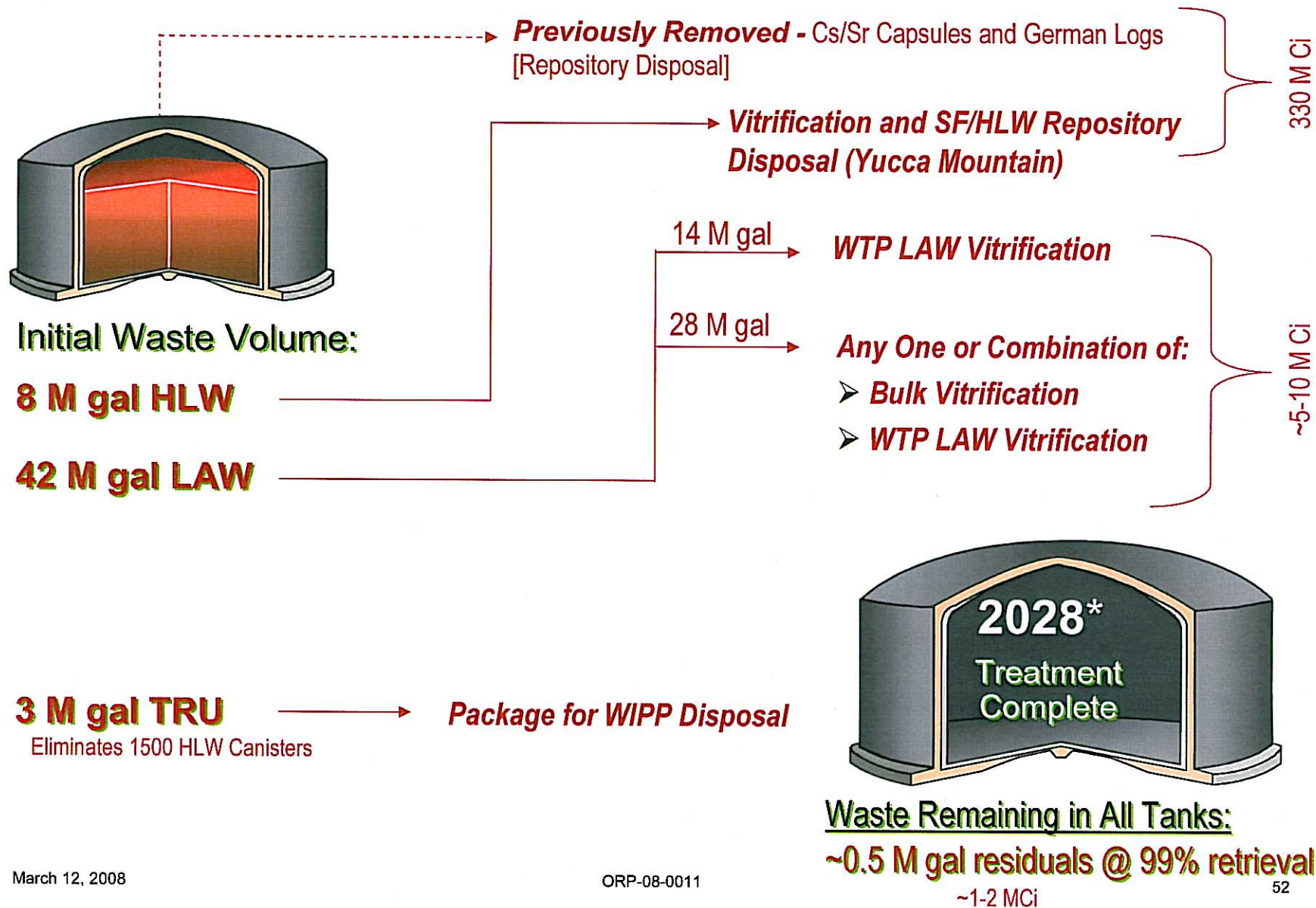


## *Where do we go From Here?*

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- New technologies will be vital to maintain retrieval progress
- Complete retrieval of C-109
- Initiate retrievals in C-104 and C-110
- Major upgrades to 242-A Evaporator
- Organizational realignment to meet the challenges of the future
  - Waste retrieval
  - Waste management
  - Infrastructure maintenance

# *The Plan: Send ~97% of Radioactivity and ~5% of Waste Volume to Yucca Mountain*





## *Extensive Tank Characterization Completed*

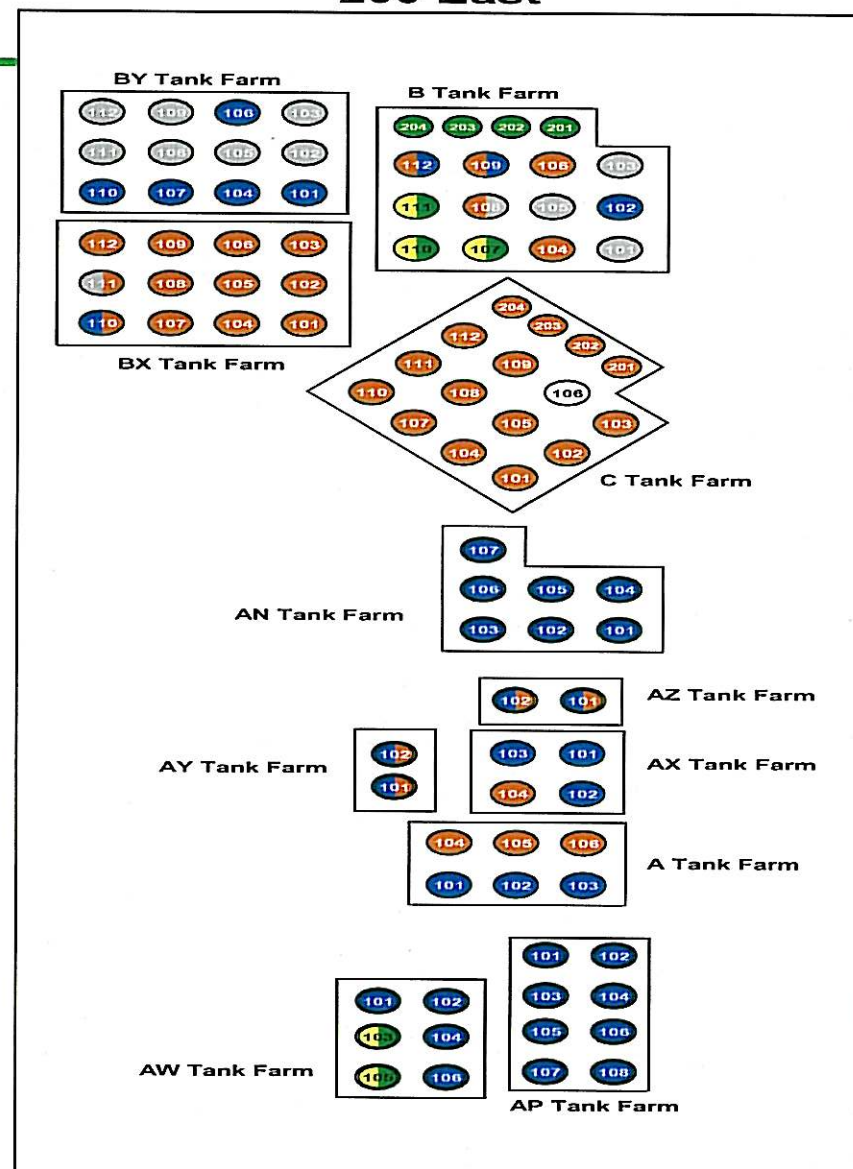
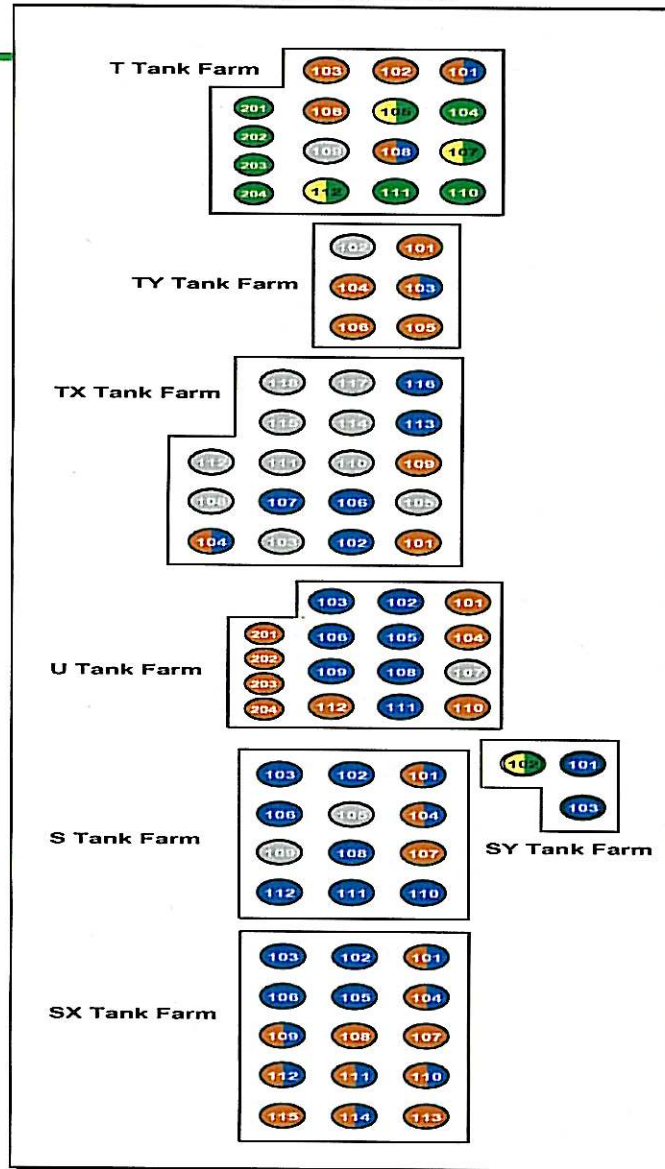
- ~~Over 600 tank samples taken since 1994~~
- Hanford Historical Process Model allows projection of sample data to all tank contents
- Extensive library of tank data
- Over 1M analytical records
- Over 40M cells of data; 634 chemical constituents and physical properties included
  - Best Basis Inventory estimates for all tanks (sampled and projected)
  - Analytical results from tank samples
  - Tank vapor sample data, temperatures and waste levels
  - Ongoing sampling to support operation

*We know what's in the tanks*

# TANK TREATMENT & DISPOSAL PATHWAYS

200 West

200 East



- Primarily Saltcake or Supernatant- ILAW Feed
- Primarily Sludge - HLW Feed
- RH - TRU
- Contact Handled - TRU Tanks
- Low Curie Feed - Supplemental Treatment
- Retrieval Complete



## *Background*

- Tank waste to be disposed through several pathways
  - WTP-HLW                      - Supplemental treatment
  - WTP-LAW                     - TRU
- Two types of WTP waste feed
  - LAW (Soluble saltcake and supernatant)
  - HLW (Insoluble sludges and cesium removed from supernatants)
- Retrievals planned based on keeping LAW and HLW process rates balanced
  - Evaluated using Hanford Tank Waste Operations Simulator (HTWOS) model
- Feed conditions and constraints described in Interface Control Documents (ICD-19)

# Hanford Tank Waste Operations Simulator

## General Input (Independent Pedigree)

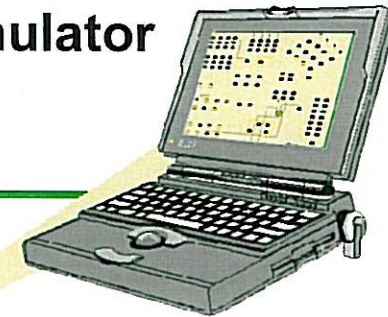
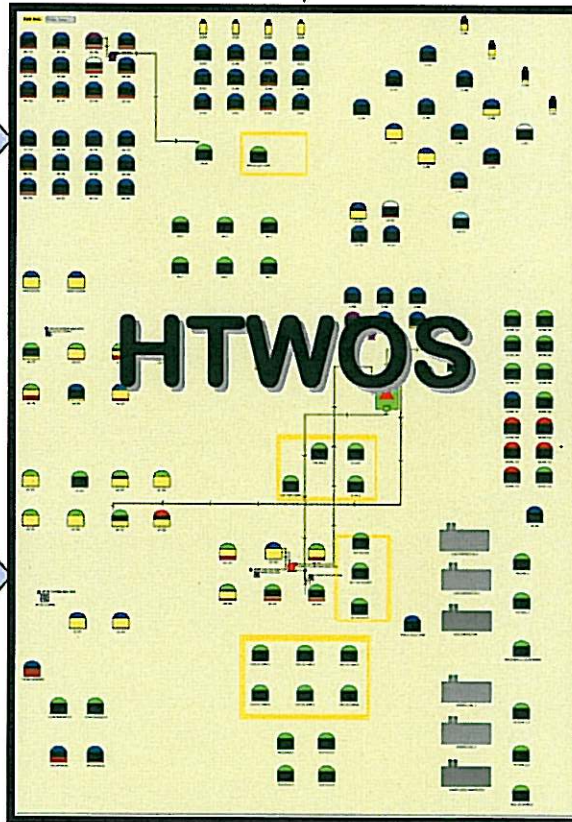
Best Basis Inventory
Historic Waste Transfers
Radioactive Decay Data
Waste Wash Factors
Caustic Leach Factors
Tank Specific Flowsheets
HLW Glass Properties Model
LAW Glass Formulation Model

## Case-Specific Input

Customer's Key Planning Assumptions
Equipment and Systems Constraints
DST Tank Usage Allocations
Non-waste Sodium Additions
Capacities and Rates
Near-term Waste Transfers
Treatment Processes
Conditioned Cs/Sr Capsule Inventory

## WTP Detailed Model

Optional Iterations



## Results (some require post-processing)

Feed Vector (Comp., Quantity, And Dates)
Total Glass Production And Glass v. Time
DST Space Usage and Volume v. Time
Projected Waste Transfers
SST Retrieval Sequence and Timing
Feed Envelope Assessment
Progress Towards 2018 Milestone
SST Risk Reduction v. Time
SST Retrieval End Date
Waste Treatment End Date
Equipment Need Dates
Input For Funding Profiles

### Simulates Waste Treatment Mission

- Mix Streams
- Partition Streams (Evaporator, IX, S/L Separation, Wash & Leach)
- Rule Based
- Dynamic (time-varying flows and compositions, discrete events)

### Subject to Constraints

- Tank Space
- Production Rates
- Transfer Rates
- Equipment Availability
- Simultaneous Transfers
- Other Relevant Constraints

### Not Addressed

- Reaction Kinetics
- Thermodynamics
- Heat Transfer
- WTP Details (internal stream compositions, cycle time, non-waste sodium additions, tank sizing and utilization, actual pretreatment throughput impact on melter)

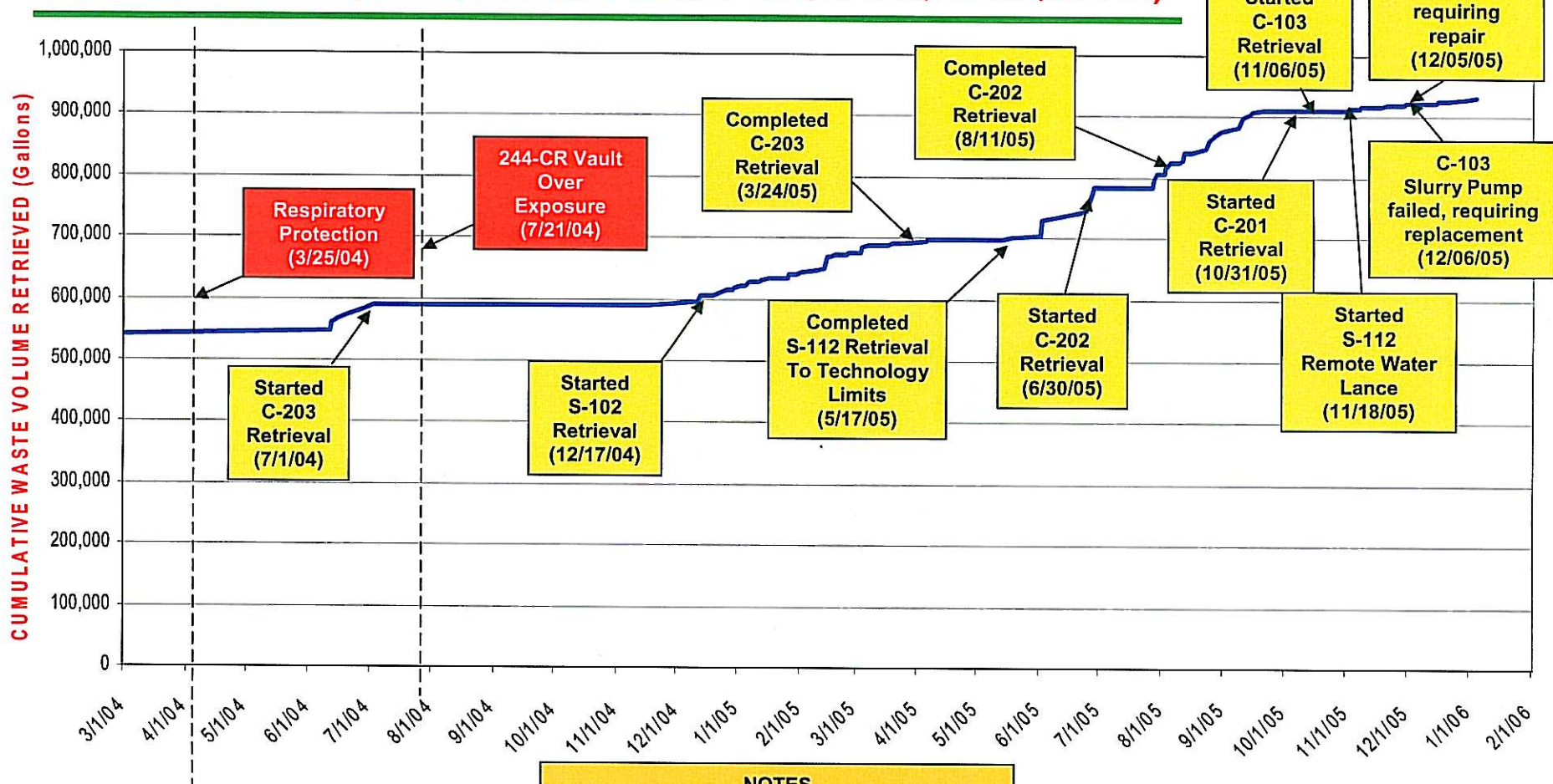


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# Cumulative Waste Retrieved

(C-103, C-106, C-201, C-202, C-203, S-102, S-112)



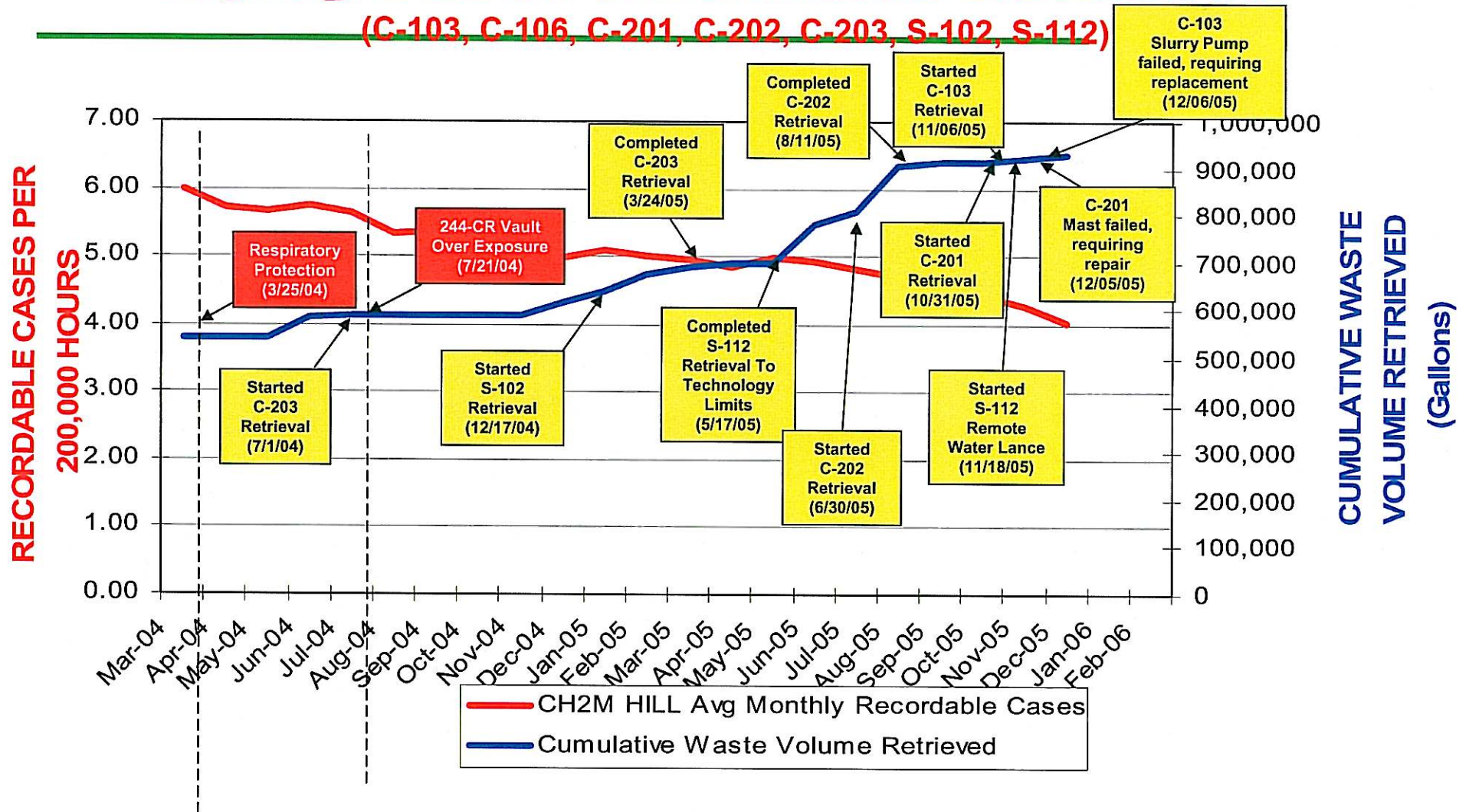
## NOTES

- Total waste volume retrieved as of 12/30/05 is 930,173 gallons
- S-102 approximately 54% complete as of 10/31/05
- S-112 completed to limits of technology; alternate retrieval technology being demonstrated
- C-106 retrieval completed 12/30/03

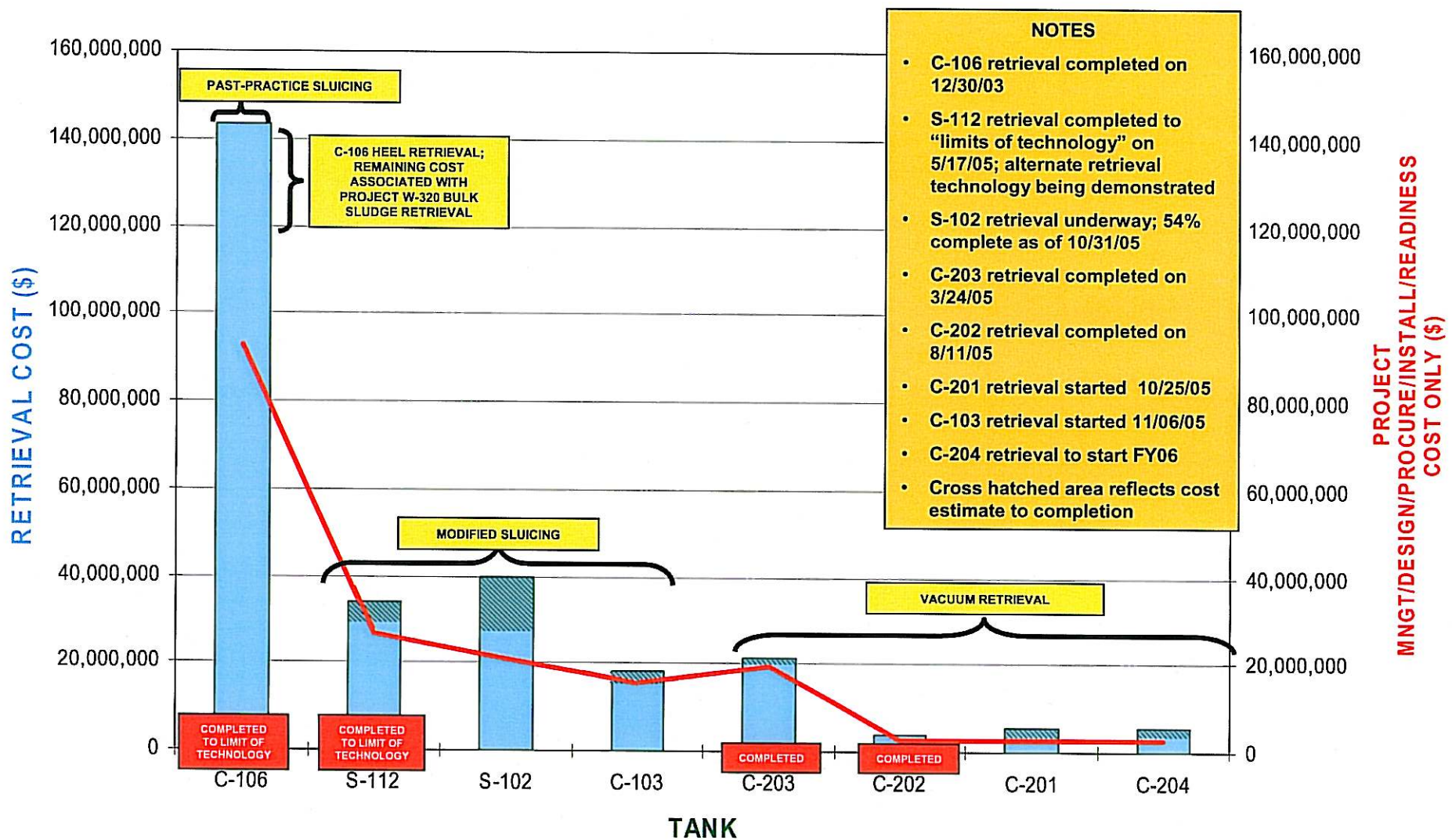


# Injury Cases vs. Volume Retrieved

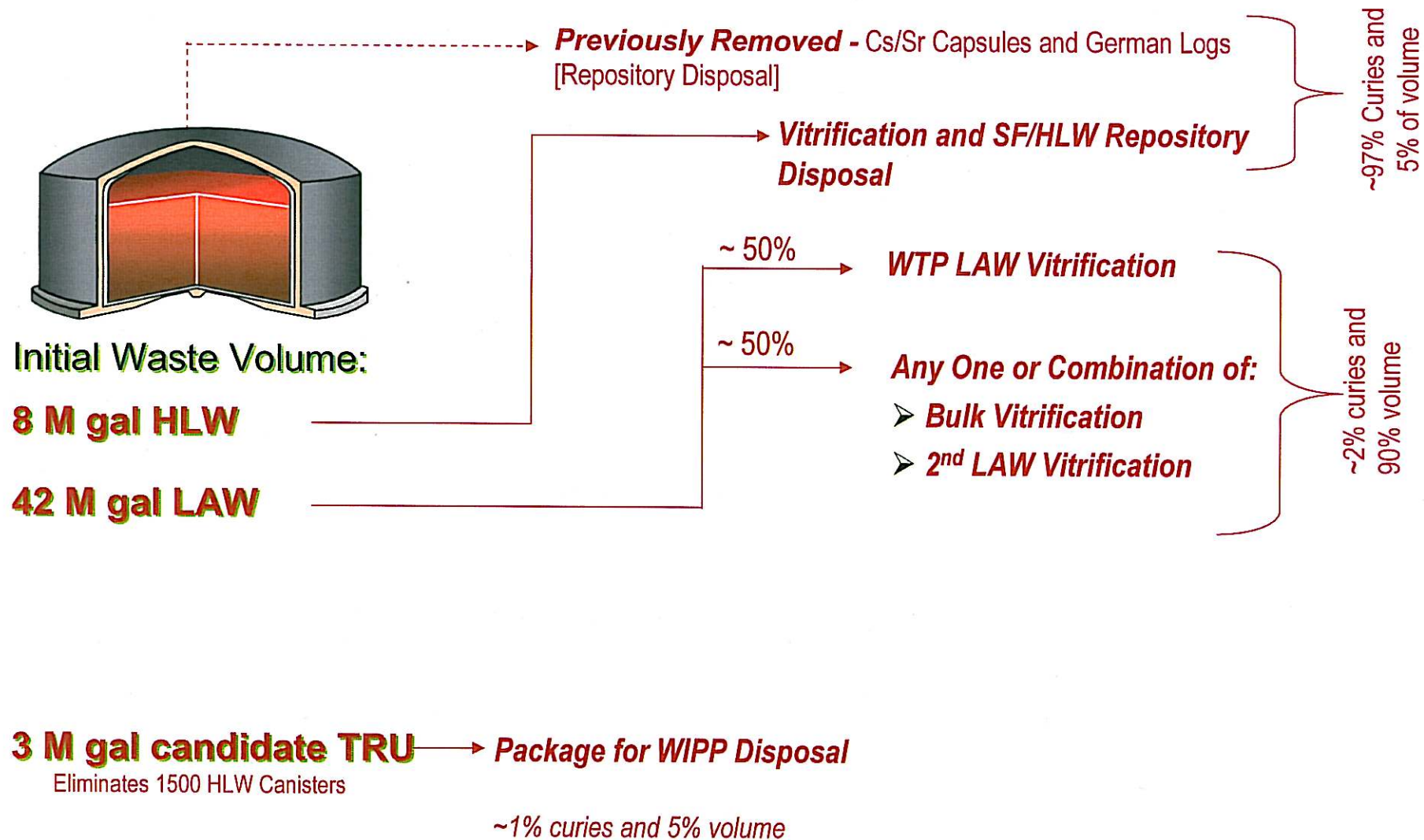
(C-103, C-106, C-201, C-202, C-203, S-102, S-112)



# Retrieval Cost By Tank







## *Tank Farm Facility Definitions*

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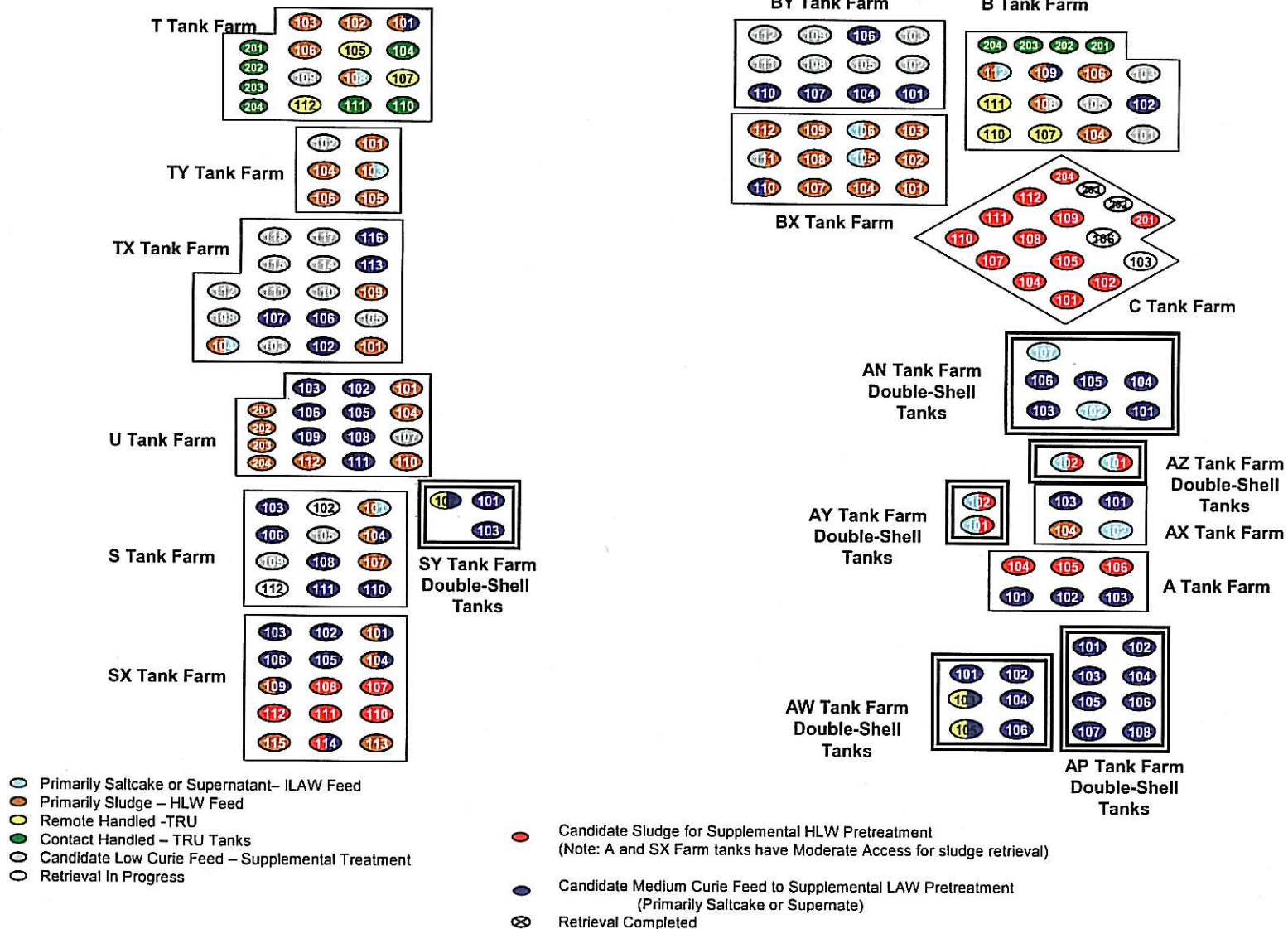
- Supplemental Pre-treatment
  - Major facility within the **tank farms** to remove the high level fraction of waste.  
Supplemental Pretreatment supports:
    - » Supplemental LAW facility in the 200 West (e.g. Bulk Vitrification)
    - » and/or supports LAW First
- Demonstration Bulk Vitrification System (DBVS)
  - Purpose is to demonstrate the viability of this down-selected technology as a supplemental LAW facility
  - Research and Development facility that will produce up to 50 boxes of glass using Tank S-109 waste
- Bulk Vitrification
  - **Production scale DBVS:** One option for LAW Supplemental Treatment. Major facility within the **Tank Farms** to supplement the Waste Treatment Plant LAW capacity
  - Processes up to 50% of the Low Activity Waste
  - Baseline has a 4-line plant in the 200 West and 4-Line Plant in the 200 East Area



# Tank Treatment & Disposal Pathways

200 West

200 East



## *Tank Waste Retrieval*

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- Retrieval of waste from older single-shell tanks continues
- Technologies based on waste characteristics and tank physical condition
- Demonstrating achievability of 99% waste retrieval
- Working with State of Washington and Nuclear Regulatory Commission on retrieval effectiveness
- Managing available Double-Shell tank space



March 12, 2008



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## *Integrated Disposal Facility*

### **Aerial View of the Integrated Disposal Facility (IDF) Site**



### **IDF Landfill Concept**

